

THE MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
Ternopil Ivan Puluj National Technical University

The department of management  
in manufacturing sphere

The course of lectures on discipline  
**ENVIRONMENTAL MANAGEMENT**  
for the 4<sup>th</sup> year students  
of the specialty 6.030601 «Management»



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## **Course Syllabus**

This course focuses on key approaches, processes, challenges, and problems related to the field of environmental management. Through the introduction of a wide variety of course materials, on-going discussions, and assignments, students will become familiar with, and equipped to engage in, the cooperative resolution of complex environmental issues.

When one thinks about the natural environment, often images of majestic waterfalls, pristine forests and wild animals wandering endless savannah come to mind. In recent years, these images are being overshadowed by the impact of human activities on the environment - images of melting polar caps, reports of depleted fish stocks, satellite imagery showing large tracts of burning forests due to anthropogenic effects, and increased incidence of diseases like SARS and swine flu that are a result of globalization and other factors. We are becoming increasingly aware of the far-reaching impacts of humans on the natural environment.

The study of environmental management requires an understanding from a multitude of perspectives, drawing upon skills from numerous areas. The effects of environmental management can be critical for both developed and developing countries, often requiring different approaches and decision-making processes.

## Course Objectives

The goal of this course is to give the student an understanding of environmental management from various scales. The student will study the natural science, political nature and policy approaches to the environment, management strategies, the process of decision-making in the environmental context, and various paradigms and sets of values which affect the strategies employed.

Historically, the focus of environmental management has been narrow, centred on how to control and utilize the environment for the benefit of humans. Today, the focus has broadened. There is the need to understand environmental issues and processes from a more encompassing perspective. In many sectors of the economy, it is necessary to understand potential solutions to environmental problems and their management. Through course content, readings and discussions, students will become familiar with important historical and current issues in environmental management, as well as approaches and processes used in the strategies employed in environmental management. By the end of this course, the student should be able to:

- ⇒ understand a variety of perspectives on environment issues and how they impact on environmental management;
- ⇒ know key historical documents and events in the study of the environmental issues and how they have shaped the current perspective in environmental management;
- ⇒ connect the current strategies employed in environmental management to a number of case studies and on multiple scales (local, national and global);
- ⇒ know the key organizations and bodies which study, regulate and manage the environment;
- ⇒ understand the interrelationships between various components in decision-making and underlying values;
- ⇒ describe the various approaches to resource environmental management; and
- ⇒ understand the nature of problems associated with sustainable development.

## ***CHAPTER I. FUNDAMENTALS OF ENVIRONMENTAL MANAGEMENT***

### **1. The essence of Environmental Management**

Environmental Management offers research and opinions on use and conservation of natural resources, protection of habitats and control of hazards, spanning the field of applied ecology without regard to traditional disciplinary boundaries. Contributions of this discipline are drawn from biology, botany, climatology, ecology, ecological economics, environmental engineering, fisheries, environmental law, forest sciences, geology, information science, public affairs, zoology and more. As the principal user of nature, humanity is responsible for ensuring that its environmental impacts are benign rather than catastrophic.

Environmental management is a process that industries, companies, and individuals undertake to regulate and protect the health of the natural world. In most cases, it does not actually involve managing the environment itself, but rather is the process of taking steps and promoting behaviors that will have a positive impact on how environmental resources are used and protected. So, the subject of environmental management - is the person or organization that provides environmental management; the object - is the activities which related to production.

Environmental management is an attempt to control human impact on and interaction with the environment in order to preserve natural resources. Environmental management focuses on the improvement of human welfare for present and future generations.

Organizations engage in environmental management for a couple of different reasons, but caring for the natural world, following local laws and rules about conservation, and saving money are usually near the top of most lists. Management plans look different in different industries, but all aim for roughly the same goals.

### **2. Environmental Management Principles**

There are five guiding principles for incorporating environmental concerns in to decision making. These principles can be used to design environmental instruments

and to raise funds to finance environmental public investments plans in the sectoral and overall budget. They are,

1. Polluter pays principle (PPP)
2. User pays principle (UPP) (or resource pricing principle).
3. Precautionary principle (PP).
4. Subsidiary principle (SP)
5. Intergenerational equity principle (IEP)

#### Polluter pays principle

The Polluter Pays Principle was first widely discussed in the United Nations Conference on Environment and Development held in Rio de Janeiro of Brazil in June 1992. This principle was endorsed by all the attending representatives of the countries.

The PPP required that the polluter has to bear the cost of complying with environmental standards, which are predetermined by public authorities. If the polluters have to pay for the cost of any pollution they cause, market forces will then encourage them to change their activities either by introducing new pollution control technologies or by switching to more efficient production process. For instance every day, individual households, firms and industries turn over million tons of tap water into wastewater, which requires proper treatment before disposal. Prior to the introduction of sewage charges (example of polluter pay principle), the cost of sewage collection and treatment came entirely from the public revenue. The disadvantages of such an arrangement are that the public is unaware of the cost of the sewage services and therefore has no incentive to reduce water pollution.

There are two objectives with PPP towards encouraging to more efficient production process, they are:

- i. To promote economic efficiency in the implementation of pollution control policies.
- ii. To minimize potential trade distortions arising from environmental policies.

PPP was partly based on equity considerations (the polluter should pay the cost of any mitigation measures), and partly ensure that countries do not provide competitive advantage for their producers by subsidizing the pollution abatement measures.

One more important point is that PPP is not necessary to achieve an efficient solution to an environmental problem and it does not require pollution to recede to zero levels, nor does it require reduction to optimal level even though it is not excluded. PP required only that the environment is in an acceptable state, which will evolve from a political process requiring inputs from local, national and international level.

There are two versions of PPP evolved. First one is equal to the price changes for the use of resources with the cost of damage over society by using them. The changes linked directed on the process that generates pollution. Difficulty with this procedure is the deciding right price to change, when the damage to the society cannot be assed in monetary terms. Later the PPP asserts the full cost of controlling pollution by an adequate measures shall be undertaken by the polluter, preferably without public subsidy or tax concession.

#### User pays principle

The UPP states that the beneficiaries should pay for the full cost of using the resources and its related service; the full cost included the cost of losses for future generations. Both PPP and UPP principle considered as equitable and both offer the prospect of achieving efficiency.

However, UPP concept has conflict with certain social objections, example all the home should connected to electricity supply, telephone service, sewage and be closed to public transport. The provision of universal services to all or most location with high marginal costs beyond the reach of most consumers is conflict with this principle. The resolution of these conflicting principles is a matter of public policy. However, this principle is more easily applied to the consumer of public services involving the collection and treatment of effluents.

#### Precautionary principle

According to Rio Declaration on Environment and Development Precautionary Principle as meaning that where there are threats of serious or irreversible damage to environment, lack of scientific certainty should not be used as s to environment for postponing cost effective measures to prevent environmental degradation.

This principle is seeking present and ease environmental stress before conclusive evidence of damage exists and adopts policy when raw evidence is available.

#### Subsidiary principle

Subsidiary principle (SP), was not designed for as an environmental principle, but it provides useful guidance when applying the PPP and UPP and the PP. SP states that political decisions should be taken by lowest possible level of public authority dependence with effective action. So that setting standards and interpreting risk are politically involved process. The SP recommend that these decisions are made by the authorities that are closed to the population concerned.

#### Intergenerational equity principle

The IEP is the central principle in the definition of sustainable development. According to the Brundtland Report sustainability states that 'meeting needs of present generations without compromising the needs of future generations'. Generally this principle is considered with the trilogy of economic, environmental and social objectives underlying sustainable development. This principle is the basis of the environmental accounting measures of sustainable income.

All the above five environmental management principles will be used to guide the sectoral policies and budgeting process.

### 3. Environmental Management System (EMS)

An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.

An EMS helps a company address its regulatory demands in a systematic and cost-effective manner. This proactive approach can help reduce the risk of non-compliance and improve health and safety practices for employees and the public.

An EMS can also help address non-regulated issues, such as energy conservation, and can promote stronger operational control and employee stewardship.

#### Basic Elements of an EMS:

Reviewing the company's environmental goals;



Analyzing its environmental impacts and legal requirements;

Setting environmental objectives and targets to reduce environmental impacts and comply with legal requirements;

Establishing programs to meet these objectives and targets;

Monitoring and measuring progress in achieving the objectives;

Ensuring employees' environmental awareness and competence

Reviewing progress of the EMS and making improvements.

#### Costs and Benefits of an EMS

Potential Costs	Potential Benefits
Internal Staff (manager) time Other employee time  (Note: Internal labor costs represent the bulk of the EMS resources expended by most organizations)	Improved environmental performance Enhanced compliance Pollution prevention Resource conservation New customers/markets Increased efficiency/reduced costs Enhanced employee morale Enhanced image with public, regulators, lenders, investors
External Potential consulting assistance Outside training of personnel	Employee awareness of environmental issues and responsibilities

Getting the right training and laying the proper groundwork during the planning phase is often one of the costliest parts of the process. Most companies do not have the expertise to train their employees, which means that this must be outsourced. A number of different consulting companies offer educational services and tutorials, often on a case-by-case or project-by-project basis. Organizations that are really serious about long-term management initiatives sometimes also choose to create new positions and hire environmental experts in a more permanent capacity.

There are also usually a number of technical costs. Special equipment may be needed to measure outputs or intakes, for instance, and software programs and special computer metrics are often required to make sense of results and readings over time. It may also be the case that managing environmental consequences requires more expensive ways of doing business. Many companies are used to doing things the least expensive way possible, which is something that must often be reconsidered when how those methods affect the environment are taken into account.

In a great many cases, the benefits of an environmental management plan far outweigh the initial expenses. These include the prevention of pollution, the conservation of natural resources like water, and increased energy efficiency. Over time, these benefits often add up to significant cost savings in bills and utility outputs. Well-executed plans can also help companies avoid costly fines in places where there is regulation of energy consumption, disposal, and other environmental concerns.

An EMS encourages a company to continuously improve its environmental performance. The system follows a repeating cycle (see figure). The company first commits to an environmental policy, then uses its policy as a basis for establishing a plan, which sets objectives and targets for improving environmental performance. The next step is implementation. After that, the company evaluates its environmental performance to see whether the objectives and targets are being met. If targets are not being met, corrective action is taken. The results of this evaluation are then reviewed by top management to see if the EMS is working. Management revisits the environmental policy and sets new targets in a revised plan. The company then implements the revised plan. The cycle repeats, and continuous improvement occurs.

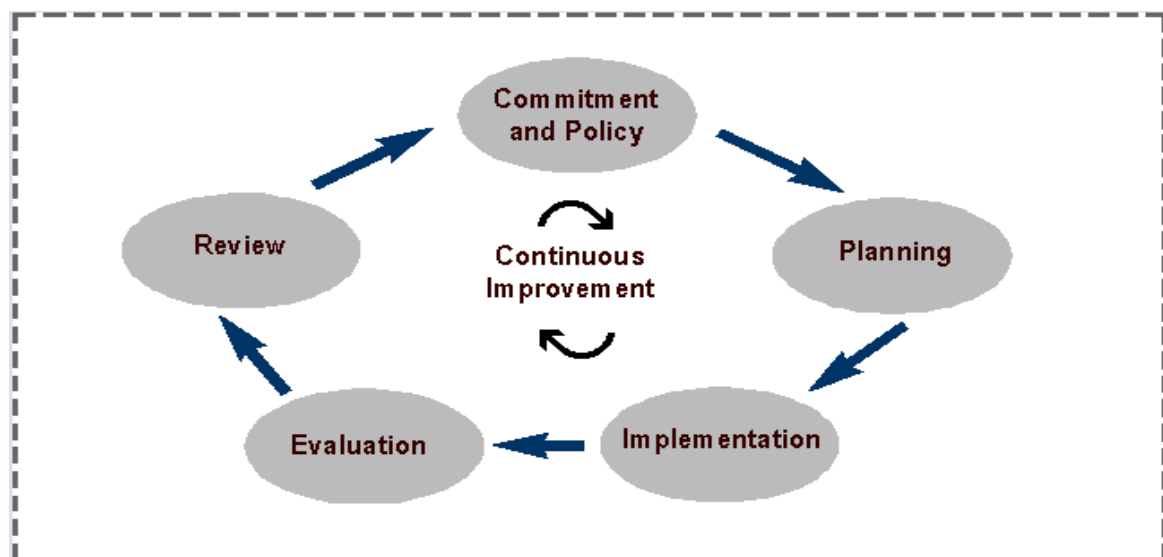


Figure 1: The continuous improvement cycle

The most commonly used framework for an EMS is the one developed by the International Organization for Standardization (ISO) for the ISO 14001 standard. Established in 1996, this framework is the official international standard for an EMS.

The five main stages of an EMS, as defined by the ISO 14001 standard, are described below:

### 1. Commitment and Policy

Top management commits to environmental improvement and establishes a company environmental policy. The policy is the foundation of the EMS.

### 2. Planning

A company first identifies environmental aspects of its operations. Environmental aspects are those items, such as air pollutants or hazardous waste, that can have negative impacts on people and/or the environment. A company then determines which aspects are significant by choosing criteria considered most important by the company. For example, a company may choose worker health and safety, environmental compliance, and cost as its criteria. Once significant environmental aspects are determined, a company sets objectives and targets. An objective is an overall environmental goal (e.g., minimize use of chemical X). A target is a detailed, quantified requirement that arises from the objectives (e.g., reduce use of chemical X by 25% by September 1998). The final part of the planning stage is devising an action plan for meeting the targets. This includes designating responsibilities, establishing a schedule, and outlining clearly defined steps to meet the targets.

### 3. Implementation

A company follows through with the action plan using the necessary resources (human, financial, etc.). An important component is employee training and awareness for all employees. Other steps in the implementation stage include documentation, following operating procedures, and setting up internal and external communication lines.

### 4. Evaluation

A company monitors its operations to evaluate whether targets are being met. If not, the company takes corrective action.

### 5. Review

Top management reviews the results of the evaluation to see if the EMS is working. Management determines whether the original environmental policy is

consistent with company values. The plan is then revised to optimize the effectiveness of the EMS. The review stage creates a loop of continuous improvement for a company.

#### 4. Environmental Problems

The poisoning of the world's land, air, and water is the fastest-spreading disease of civilisation. It probably produces fewer headlines than wars, earthquakes and floods, but it is potentially one of history's greatest dangers to human life on earth. If present trends continue for the next several decades, our planet will become uninhabitable.

Overpopulation, pollution and energy consumption have created such planet-wide problems as massive deforestation, ozone depletion, acid rains and the global warming that is believed to be caused by the greenhouse effect.

The seas are in danger. They are filled with poison: industrial and nuclear waste, chemical fertilisers and pesticides. The Mediterranean is already nearly dead; the North Sea is following. The Aral Sea is on the brink of extinction. If nothing is done about it, one day nothing will be able to live in the seas.

Every ten minutes one kind of animal, plant or insect dies out for ever. If nothing is done about it, one million species that are alive today will have become extinct twenty years from now. Air pollution is a very serious problem. In Cairo just breathing the air is life threatening- equivalent to smoking two packs of cigarettes a day. The same holds true for Mexico City and 600 cities of the former Soviet Union.

Industrial enterprises emit tons of harmful substances. These emissions have disastrous consequences for our planet. They are the main reason for the greenhouse effect and acid rains. An even greater environmental threat are nuclear power stations. We all know how tragic the consequences of the Chernobyl disaster are.

People are beginning to realise that environmental problems are not somebody else's. They join and support various international organisations and green parties. If governments wake up to what is happening- perhaps we'll be able to avoid the disaster that threatens the natural world and all of us with it.

## ***Chapter 2 Sustainable Manufacturing***

Earth's resources are limited. With the explosion in world population and the increasing rate of consumption, it will be increasingly difficult to sustain the quality of life on earth if serious efforts are not made now to conserve and effectively use the earth's limited resources. It is projected that the current world population of 5.6 billion people would rise to 8.3 billion people by the year 2025 [Furukawa 1996], This is an increase of 48.21% from the current level. Yet, earth's resources such as fossil fuels, landfills, quality air and water are increasingly being depleted or polluted. So, while there is a population growth, there is a decline in the necessary resources to sustain the increasing population. Since the mid- 1980s, we have witnessed a rapid proliferation of new products with shorter life cycles. This has created tremendous wastes that have become problematic as more and more of the landfills are usurped. Increasingly, more and more environmental activist groups are forming and with consumer supports, are putting pressures on corporations to improve their environmental performance. These efforts are also being supported by the increase in the number of new legislatures to protect the natural environment. Thus, responsible manufacturing is needed to achieve sustainable economic development. Strikingly, studies have linked economic growth to environmental pollution [Madu 1999], Thus, there is a vicious cycle between improved economic development and environmental pollution. This traditional belief in a link between environment pollution and economic growth often is a hindrance to efforts to achieve sustainable development. Sustainable manufacturing is therefore, a responsible manufacturing strategy that is cognizant of the need to protect the environment from environmental pollution and degradation by conserving the earth's limited resources and effectively planning for the optimal use of resources and safe disposal of wastes. In the past, manufacturers have been lukewarm about any strategy to develop sustainable manufacturing. They viewed such strategies as expensive and not economically viable. However, this mood is gradually changing as more and more big companies are developing environmentally conscious manufacturing strategies through their entire supply chain. Many have also seen that environmentally conscious manufacturing can become an effective competitive strategy. Thus, sustainable manufacturing makes wise

business sense and can lead to improved bottom-line. We shall in this chapter, trace the origins of sustainable development, which gave rise to sustainable manufacturing. Further, we shall identify different strategies to sustainable manufacturing and then present cases of successful implementation of sustainable manufacturing by multinational corporations such as Kodak and Xerox.

### Sustainable Development

The origins of sustainable development can be traced to the United Nations publication in 1987 titled the Brundtland Report. This report is named after Mrs. Brundtland, Prime Minister of Norway who chaired the UN World Commission on Environment and Development. The report focused on the problems of environmental degradation and states that "the challenge faced by all is to achieve sustainable world economy where the needs of the entire world's people are met without compromising the ability of future generations to meet their needs." This report received an international acclaim as more and more people are concerned with the theme of the report on environmental degradation. Since its publication, the world community has convened several conferences on how to achieve sustainable development. In 1992, the UN organized the Earth Summit in Rio de Janeiro, Brazil with a focus on how to get the world community to cut down on the use of nonrenewable resources in order to achieve sustainable development. This conference highlighted the disparate views between the industrialized and the developing countries on how sustainable development could be achieved with those from the Southern Hemisphere seeing dependence on the use of natural resources as a prerequisite to their economic growth. Several publications have emerged on sustainable development since the conference.

Duncan [1992] defined sustainable development as an "economic policy which teaches that society can make the appropriate allocation of resources between environmental maintenance, consumption, and investment." However, such balance is difficult to achieve when a nation becomes completely dependent on the exploitation of natural resources to satisfy its social and economic needs [Madu 1996]. Furthermore, with the absence of a developed private sector, countries faced with harsh economic realities such as poverty and over population, are more likely to focus on exploitation of

natural resources and deployment of inappropriate technologies for manufacturing. Such attempts may hinder the global efforts to achieve sustainable development. Following this debate, Singer [1992] argues that sustainable development is akin to a "New Economic Order" that may not encourage reasonable and realistic development from the Southern Hemisphere. Rather, it could be seen as an attempt to make the South financially dependent on the North. This he refers to as a Robin Hood effect which may result in the transfer of funds from the poor in the rich countries to the rich in the poor countries. Clearly, achieving sustainable development is a goal for the entire world otherwise; marginal efforts by each country will be ineffective. Fukukawa [1992] pointed out that "current global environmental problems may bring about a crisis that could never have been anticipated by our predecessors. Since the very inception of history, humankind has been pursuing technological development to protect itself from the threats and constraints of nature. However, economic activities triggered by these technological developments have grown large enough to destroy our vital ecosystem." This view is shared by many around the world and has been a motivating force in seeking for responsible manufacturing through sustainable manufacturing. While many companies in the industrialized countries have embarked on the road to sustainable development, it is important to achieve environmental conformance throughout the world. After all, noncompliance may affect the supply chain especially since some of the raw materials may be generated from the poorer nations. Getting these countries to participate in sustainable development will requires understanding their perspectives on economic and social development and how they could be assisted by the more affluent nations. The problems in developing countries are better explained by Kamal Nath, India's then Minister of the Environment, when he noted in the Rio de Janeiro conference that "Developed countries are mainly responsible for global environmental degradation and they must take the necessary corrective steps by modifying consumption patterns and lifestyles; developing countries can participate in global action, but not at the cost of their development efforts ... On climate change and greenhouse gases, India's stand is that global warming is not caused by emissions of the gases per se but by excessive emissions. The responsibility for cutting back on

emissions rests on countries whose per capita consumption is high. India's stand is that emission in developed countries be reduced to tally with the per capita emission levels of developing countries." This view obviously, is controversial in industrialized countries. However, what it points out is the link or the perception of a link between environmental pollution and economic growth. In fact, as Figure 2.1 shows, the emission levels of carbon tend to support such a link. This figure, suggests a direct relationship between carbon emission and economic growth when the cases for OECD (Organization of Economic Cooperation and Development) are compared to the cases for non-OECD nations.

In 1997, the UN conference on Climate Change was held in Kyoto, Japan. This conference further raised some doubts and disagreements between member nations, non-governmental organizations, labor unions, and environmental activists. A preamble placed on the Internet states as follows, "The threat of global warming has brought more than 140 governments together in intensive negotiations to try to limit the emission of carbon dioxide and other greenhouse gases that trap heat in the atmosphere. But history, geography, economics and politics are driving them apart. Island states fear the rising oceans that warming may cause. Oil producers fear what lessening the world's dependence on fossil fuels would mean to them. Big industrial nations worry that emission limits might slow their economies. Poor nations say they should not have to bear the same burden as the rich." Obviously, sustainable development is intertwined with politics and economics and these may impede the effort to achieve sustainable development. Strategies to achieve this goal must therefore, take into consideration these concerns. Clearly, sustainable development cannot be achieved without sustainable manufacturing. Sustainable manufacturing is one of the processes or strategies to achieve the goal of sustainable development.

Sustainable manufacturing as a strategy will require the re- engineering of the organization to change design, process, work attitudes and perceptions. It requires the entire organization to be environmentally conscious and will require the support and participation of top management. More importantly, it will require investment in the future and retraining of the work force. Sustainable manufacturing is a capital venture



that a company must undertake and this is a risk that some may not yet be ready for especially from the developing economies. Yet, from all indications, those corporations that have embarked on this bold step are reporting dramatic successes as we shall outline later.

The Brundtland Report was instrumental in getting the world focus on sustainable development. However, the formation of the Business Charter for Sustainable Development (BCSD) by a group of 50 business executives provided the momentum for much of businesses involvement in sustainable manufacturing. BCSD was formed in 1990 in preparation of Business activities at UNCED. This group was headed by Stefan Schmidheiny and published a book titled "Changing Course." This book detailed with case studies, challenges facing business in a sustainable environment. In January 1995, BCSD merged with another influential group with strong business ties known as the World Industry Council for the Environment (WICE). WICE is an initiative of the International Chamber of Commerce (ICC) based in Paris while BCSD was based in Geneva. These two groups shared common goals and attracted executives from similar organizations although BCSD was an executive- based group. The result of this merge is the World Business Council for Sustainable Development (WBCSD). WBCSD is presently, a coalition of 125 international companies that share a commitment to environmental protection and to the principles of economic growth through sustainable development. Its membership is drawn from 30 countries and more than 20 major industrial sectors. The aims of WBCSD as listed in its web page are stated below as follows (<http://www.wbcds.ch/whatis.htm>):

Business leadership—To be the leading business advocate on issues connected with the environment and sustainable development;

Policy development—To participate in policy development in order to create a framework that allows business to contribute effectively to sustainable development;

Best practice—To demonstrate progress in environmental and resource management in business and to share leading-edge practices among our members;

Global outreach—To contribute through our global network to a sustainable future for developing nations and nations in transition.

The participation and support of many executives and major industrial sectors in sustainable development issues gave the momentum to corporate focus on sustainable manufacturing or environmentally conscious manufacturing.

Schmidheiny in his 1992 article discusses the term ecoefficiency. He defines it as "companies which add the most value with the least use of resources and the least pollution." This definition clearly linked industrial production to achieving sustainable development and shows that ecoefficiency or sustainable development can be achieved only when limited natural resources are optimized and environmental waste and pollution are minimized. Thus, corporate responsibility for sustainable development is obvious and corporations and their executives by participating in WBCSD are leading the way to achieving sustainable manufacturing. Sustainable manufacturing is therefore, synonymous to ecoefficiency. We shall therefore, define sustainable manufacturing as a means for manufacturers to add the most value to their products and services by making the most efficient use of earth's limited resources, generating the least pollution to the environment, and targeting for environmental clean production systems. Although we emphasize sustainable manufacturing, it should be apparent that the goal of environmental clean production cannot be achieved if the service component of the manufacturing system is not environmentally conscious. The service sector must contribute by ensuring that its services are environmentally efficient. For example, can the purchasing and receiving department conserve its use of paper for placing orders? Obviously, such a simple case can be achieved by using recycled papers and packaging, and by placing most orders through interconnected computers or the Internet in a paperless environment. Thus, our focus is on both the manufacturing and service sector working in harmony to achieve the goal of environmentally conscious manufacturing.

### Strategies for Sustainable Manufacturing

Several strategies have been developed to achieve sustainable manufacturing. We shall briefly discuss the different strategies. The aim of each of these strategies is to find a better way to make more efficient use of the earth's limited resources, minimize pollution and waste. Some of these strategies may appear in more details in subsequent chapters.

- **Inverse Manufacturing**—This strategy is based on prolonging the life of a product and its constituent components. Umeda [1995] refers to this as a closed-loop product life cycle. Simply stated, the life of any product can be extended by disassembling the original product at the end of its original life into components that could be reused, recycled, maintained or up-graded. Focus is

on limiting the amount of components that are disposed or discarded as wastes. When this is done, environmental costs are minimized [Yoshikama 1996]. Inverse manufacturing gets its name from the reverse approach to recovery of the components that make up a product. Due attention is given at the conception of the product to the ease of disassembly. This will make it possible to reclaim component parts for future use thereby prolonging the life of the product. There are many examples of inverse manufacturing. For example, older computers are frequently upgraded to give them more capabilities. By retaining much of the computer unit and adding only the needed features, its life is further extended. Also, important precious metals present in some older computer units such as silver, platinum and gold can be extracted and reused in building newer models when it is no longer economical or feasible to upgrade the unit. These activities reduce waste through recovery, recycling and reuse of materials. In the paper industry also, the use of recycled paper rather than virgin pulp in new paper production prolongs the life of the original virgin pulp. Inverse manufacturing has obvious advantages in extending the life of the product, minimizing waste of materials and conserving the landfills. The goal however, should be to keep waste to a bare minimum.

- **Recycling**—Recycling is one of the better-known strategies for sustainable manufacturing. In most communities, it is mandatory to participate in recycling programs. Many people identify with recycling of newspapers, packages, soda cans, bottles, and in fact, are required to separate them from other garbage for recycling purposes. Although there are arguments about the weaknesses of the current day recycling policies, however, the aim of recycling is to focus our attention on the finite resources available to mankind. The earth is composed of about 30% land and the rest is water. Our landfills are gradually filling up. If we continue to discard and dump wastes,

the landfills will be filled up. We depend on the limited earth's resources for economic growth and if we are not able to thoroughly recycle and extend the lives of these resources, the future will be blink. Thus, a recycling policy that is efficient is needed. Such policy should be efficient and encourage more people and industries to participate in the program.

- Re-manufacturing—is the process of rebuilding a unit or machinery to restore its condition to "as good as new." This may involve reuse of existing components after overhaul, replacement of some component parts, and quality control to ensure that the remanufactured product will meet new product's tolerances and capabilities. The remanufactured product will normally come with a new product warranty. To make remanufacturing effective, the following steps are normally taken:

Collection of used items—This could be achieved through a recycling program where used or expired original products are collected from the customer and reshipped to the manufacturer. Some examples of these are drum and toner cartridges for computer printers and photocopying machines, auto parts, etc.

These items on receipt are inspected based on their material condition and a determination can be made on the economic feasibility of remanufacturing them.

Subsequently, the items are disassembled. If the full unit cannot be remanufactured, some components may be recovered for use in other components. Otherwise, the original item can be restored to a condition as good as new through repair and servicing. The recovery process must be efficient and focus on strategies that are conducive to the environment.

It is important that new products are designed for ease of disassemble and recovery of parts. This will make it more economical to conduct remanufacturing activities since it will be easier to determine which parts need repair or replacement. This will also help in effective planning of the master production scheduling by minimizing the production planning time and parts inventory levels.

- Reverse logistics—requires that manufacturers take a "cradle-to- grave" approach of their products. This management of a product through its life cycle does not end with the transfer of ownership to the consumer and the expiration of warranty.

Rather, the manufacturer is forever, responsible for the product. This is often referred to as "product stewardship." [Dillion and Baram 1991]. Roy and Whelan [1992] noted that this is a "systematic company efforts to reduce risks to health and the environment over all the significant segments of a product life cycle." Product stewardship is driven by public outcry about the degradation of the environment. This has led to new legislatures making manufacturers responsible for the residual effects of their product on the environment with no time limit. As a result, more and more companies are responding by developing environmentally responsible strategies. Some are also seeing that such strategies are good for business and may lead to competitive advantages. The concept of product stewardship as outlined by Roy and Whelan [1992] requires a focus on the following:

- Recycling

- Evaluation of equipment design and material selection

- Environmental impact assessment of all manufacturing processes

- Logistics analysis for the collection of products at the end of their lives

- Safe disposal of hazardous wastes and unusable components

- Communication with external organizations—consumer groups legislature, and the industry at large.

This focus is embodied in the reverse logistic strategy. It is a new way for manufacturers to view their products and develop a business model that could enable them to profit from developing a product stewardship approach. Obviously, by using remanufacturing strategy, the manufacturer can save significantly from the cost of labor and materials. Giuntini [1997], Note that about 10 to 15% of the gross domestic product could be affected, by adopting reverse logistic as a business strategy. Furthermore, about 50 to 70 percent of the original value of an impaired material can be recovered from customers. In addition, the cost of sales (direct labor, direct material, and overhead) which currently, averages 65 percent to 75 percent of the total cost structure of a manufacturer can be reduced by as much as 30 percent to 50 percent through reverse logistics. He identified the by-products of reverse logistics as follows:

Industrial waste throughout the manufacturing supply chain, would be reduced by as much as 30 percent

Industrial energy consumption would be noticeably reduced

Traditionally under-funded environmental and product liability costs would be better controlled and understood.

He suggested the following 10 steps for a manufacturer to implement a reverse logistics business strategy:

Products must be designed for ease of renewal, high reliability, and high residual value.

Financial functions must be restructured to cope with different cash-flow requirements and significant changes in managerial accounting cues.

Marketing must reconfigure its pricing and distribution channels.

Product support services and physical asset condition monitoring management systems must be implemented to manage manufacturer-owned products at customer sites.

Customer order management systems must be implemented to recognize the need for the return of an impaired asset from a customer site.

Physical recovery management systems must be implemented to manage the return of impaired physical assets.

Material requirements planning management systems must be implemented to optimize the steps required to be taken upon the receipt of recovered impaired assets.

Renewal operational processes must be established to add value to impaired assets.

Re-entry operational processes must be established to utilize renewed assets.

Removal processes must be established to manage nonrenewed assets.

- Eco-labeling—The aim of eco-labeling is to make consumers aware of the health and environmental impacts of products they use. It is expected that consumers will make the right decision and choose products that will have less environmental and health risks. By appropriately labeling the product and providing adequate product information for consumers to make the choice between alternative products, it is hoped

that manufacturers will move towards developing environmentally conscious production systems. Eco-labeling as a strategy is therefore, intended to identify the green products in each product category. It could be perceived as a marketing strategy that is partly driven by legislatures and partly driven by consumers concern for the degradation of the environment. Many of the eco-labeling schemes are based on the life cycle assessment (LCA) of a product and take the "cradle-to-grave" approach by evaluating the environmental impacts of the product from the extraction of the raw material to the end of the product's useful life. However, some of the popular eco-labeling schemes do not take this approach. The German "Blue Angel" mark which is one of the best known eco-labeling schemes focuses on the environmental impacts of the product at disposal and the Japanese EcoMark focus on the contributions of the product to recycling Using Eco-labeling, (<http://www.uia.org/uiademo/str/v0923.htm>).

Eco-labeling is increasingly being used in many industries and consumers are paying attention as opinion polls tend to suggest [Using eco labeling, 1999]. However, for eco-labeling to be effective, the public needs to be well informed and the labeling scheme must be credible. As has been suggested, it is important that all the major stakeholders (i.e., consumers, environmental interest groups, and producers) participate in developing the eco-labeling schemes. Also, information presented on the content of the product has to be valuable and understandable to consumers. There is a need for a standardized scheme in each product category to make it easier for comparative judgments. One of the major problems facing eco-labeling schemes is that it is voluntary and often, administered by third parties. Bach [1998] argued that mandatory eco-labeling schemes would be illegal within the context of the World Trade Organization and act as a barrier against international trade. He is of the opinion that regulatory measures will not reduce environmental degradation and further note that different countries have different environmental policies and standards as well as different economic policies and standards.

However, market forces and not government laws and legislatures drive eco-labeling. We operate in a global environment and without a standardized eco-labeling scheme; the entire supply chain will be affected. It is clear that many producers in

industrialized countries source their raw materials and parts from different countries. If a standardized eco-labeling scheme is not developed, the entire supply chain will be affected and it will be difficult to implement an eco-labeling scheme that is based on a cradle-to-grave approach. Furthermore, the changes we have observed in the market economy since the 1980s as a result of the total quality movement (TQM) and the subsequent development of the ISO 9000 series of product standards suggest that international standards on eco-labeling are not far from implementation. In fact, with the success of ISO 9000, the International Organization for Standards (ISO) has developed the ISO 14000 series of standards with a focus on guidelines and principles of environmental management systems. The technical committee (TC 207) charged with developing standards for global environmental management systems and tools, has environmental labeling as part of its focus. ISO 14020 deals with the general principles for all environmental labels and declarations [Madu 1998]. As expected, these standards will be widely adopted and when that happens, businesses will be expected to follow accordingly in order to compete in global markets. ISO already has classifications for eco-labeling schemes and the Type I eco-labels have the greatest impact on international trades. A third party to products that meet specified eco-labeling criteria grants certification. The issue is not to have each country develop its own plan for eco-labeling but, for world bodies such as ISO to institute a standardized scheme that will be cognizant of the limitations poorer nations may face. Indeed, ISO has four standards dealing with eco-labeling. These are ISO 14020, ISO 14021, and ISO 14024 and ISO 14025. Although ISO standards are voluntary, with the worldwide acceptance of ISO, it is expected that many companies and countries will work within the guidelines of these standards. Environmental protection should be a worldwide effort and without such an effort, the whole idea will be marginalized. Finally, some have argued that eco-labels do not boost sales [Christensen 1998] but it is too early to verify this claim since the public has to be sufficiently aware. Also, sales should not be the single criterion for environmental protection. Due concern should be given to the consumer's need to be aware of the content of the product and having the ability to make a purchasing decision based on that information.



- ISO 14000—is a series of international standards on environmental management. These standards are being put up by the International Organization for Standards (ISO) with the objective to meet the needs of business, industry, governments, non-governmental organizations and consumers in the field of the environment. These standards are voluntary; however, they continue to receive the great support of ISO member countries and corporations that do business in those countries. We shall not go into the details of these standards since ISO 14000 is a chapter in this book. We shall however, present a table that lists the ISO 14000 standards and other working documents at the time of writing. This is to help draw your attention to the work done by ISO on environmental management. However, the work of the ISO technical committee working on ISO 14000 family of standards is to address the following areas:

Environmental management systems.

Environmental auditing and other related environmental investigations

Environmental performance evaluations.

Environmental labeling.

Life cycle assessment.

Environmental aspects in product standards.

Terms and definitions.

Table 2.1 shows the listing of approved standards and drafts at their different stages of development as of 1999. Later on in Chapter 4, we shall present an updated version of these standards which was last revised on November, 2004.

Table 2.1: ISO 14000 Family of Standards and Ongoing Work

Designation	Publication	Title
ISO 14001	1996	Environmental management system—Specification with guidance for use
ISO 14004	1996	Environmental management system—General guidelines on principles, systems and supporting techniques
ISO 14010	1996	Guidelines for environmental auditing—General principles
ISO 14011	1996	Guidelines for environmental auditing—Audit procedures—Auditing of environmental management systems

ISO 14012	1996	Guidelines for environmental auditing—Qualification criteria for environmental auditors
ISO/WD 14015	To be determined	Environmental assessment of sites and entities
ISO 14020	1998	Environmental labels and declarations—General principles
ISO/DIS 14021	1999	Environmental labels and declarations—Self declared environmental claims
ISO/FDIS 14024	1998	Environmental labels and declarations—Type I environmental labeling—Principles and procedures

Table 2.1: (Continued)

Designation	Publication	Title
ISO/AVD/TR 14025	To be determined	Environmental labels and declarations—Type III environmental declarations—Guiding principles and procedures
ISO/DIS 14031	1999	Environmental management—Environmental performance evaluation—Guidelines
ISO/TR 14032	1999	Environmental management—Environmental performance evaluation—Case studies illustrating the use of ISO 14031
ISO 14040	1997	Environmental management—Life cycle assessment—Principles and framework
ISO 14041	1998	Environmental management—Life cycle assessment—Goal and scope definition and inventory analysis
ISO/CD 14042	1999	Environmental management—Life cycle assessment—Life cycle impact assessment
ISO/DIS 14043	1999	Environmental management—Life cycle assessment—Life cycle interpretation
ISO/TR 14048	1999	Environmental management—Life cycle assessment—Life cycle assessment data documentation format
ISO/TR 14049	1999	Environmental management—Life cycle assessment—Examples for the application of ISO 14041
ISO 14050	1998	Environmental management—Vocabulary
ISO/TR 14061	1998	Information to assist forestry organizations in the use of the Environmental Management Systems standards ISO 14001 and ISO 14004
ISO Guide 64	1997	Guide for the inclusion of environmental aspects in product standards

Notes:

CD = Committee Draft;

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Life cycle assessment—we shall adopt the definition provided by ISO for life cycle assessment (LCA). It is defined as "a technique for assessing the environmental

aspects and potential impacts associated (with products and services)... LCA can assist in identifying opportunities to improve the environmental aspects of (products and services) at various points in their life cycles." This concept is often referred to as the "cradle-to- grave" approach. It requires that emphasis be placed on the environmental impacts of production or service activities from the product conception stage (i.e., raw material generation) to the end of the product's life (i.e., recovery, retirement or disposal of the product). Thus, the manufacturer is responsible for the environmental impacts of the product through different stages in its life cycle. Life cycle assessment often involve three major activities [Affisco 1998]:

Inventory analysis—this deals with the identification and quantification of energy and resource use as well as environmental discharges to air, water and land.

Impact analysis—is a technical assessment of environmental risks and degradation.

Improvement analysis—identifies opportunities for environmental performance improvement.

Notice also that several of the ISO standards listed in Table 1 deal with Life Cycle Assessment. Already, ISO 14040 on principles and framework and ISO 14041 on goal and scope definition and inventory analysis have been adopted as standards.

Design for the environment—consequent to the growing demand for improvement in environmental performance is the growing need to change the traditional approach to designing. This strategy calls for an efficient designing of products for environmental management. Products are to be designed with ease of disassembly and recovery of valuable parts. Such design strategies will conserve energy and resources while minimizing waste. In designing for the environment, tradeoffs are made between the different environmental improvements over the product life cycle. Three main design strategies are design for recyclability; design for remanufacture; and design for disposal.

Design for recyclability—This involves the ease with which a product can be disassembled and component parts recovered for future use. For example, with computer units, precious metals can be easily recovered for use in new computers. For

chemical compounds, the focus is on separability of materials to avoid contamination and waste of energy in recovering these materials.

Design for Remanufacture—This recognizes the different stages of equipment or product wears. For example, certain parts of machinery (i.e., auto parts) could be recovered, remanufactured and restored to a state as good as new. Reusing them in newer products could further extend the lives of such parts. The challenge is how to design the original product for ease of recovery of those parts. We notice for example that newer computer systems are designed with the ease of upgrading them. Thus, new capabilities could be added to the system without having to dispose of the old unit.

Design for disposability—This recognizes the fact that many of the earth's landfills are filling up at an alarming rate. Further, many of the deposits are hazardous and unsafe. It is important to design the product with the ease of recycling and disposal. The final waste generated from the product should also be disposed safely.

### ***Chapter 3 Strategies for Sustainable Manufacturing***

Several strategies have been developed to achieve sustainable manufacturing. We shall briefly discuss the different strategies. The aim of each of these strategies is to find a better way to make more efficient use of the earth's limited resources, minimize pollution and waste. Some of these strategies may appear in more details in subsequent chapters.

- **Inverse Manufacturing**—This strategy is based on prolonging the life of a product and its constituent components. Umeda [1995] refers to this as a closed-loop product life cycle. Simply stated, the life of any product can be extended by disassembling the original product at the end of its original life into components that could be reused, recycled, maintained or up-graded. Focus is on limiting the amount of components that are disposed or discarded as wastes. When this is done, environmental costs are minimized [Yoshikama 1996]. Inverse manufacturing gets its name from the reverse approach to recovery of the components that make up a product. Due attention is given at the conception of the product to the ease of disassembly. This will make it possible to reclaim component parts for future use thereby prolonging the life of the product. There are many examples of inverse manufacturing. For example, older computers are frequently upgraded to give them more capabilities. By retaining much of the computer unit and adding only the needed features, its life is further extended. Also, important precious metals present in some older computer units such as silver, platinum and gold can be extracted and reused in building newer models when it is no longer economical or feasible to upgrade the unit. These activities reduce waste through recovery, recycling and reuse of materials. In the paper industry also, the use of recycled paper rather than virgin pulp in new paper production prolongs the life of the original virgin pulp. Inverse manufacturing has obvious advantages in extending the life of the product, minimizing waste of materials and conserving the landfills. The goal however, should be to keep waste to a bare minimum.

- **Recycling**—Recycling is one of the better-known strategies for sustainable manufacturing. In most communities, it is mandatory to participate in recycling programs. Many people identify with recycling of newspapers, packages, soda cans,

bottles, and in fact, are required to separate them from other garbage for recycling purposes. Although there are arguments about the weaknesses of the current day recycling policies, however, the aim of recycling is to focus our attention on the finite resources available to mankind. The earth is composed of about 30% land and the rest is water. Our landfills are gradually filling up. If we continue to discard and dump wastes, the landfills will be filled up. We depend on the limited earth's resources for economic growth and if we are not able to thoroughly recycle and extend the lives of these resources, the future will be bleak. Thus, a recycling policy that is efficient is needed. Such policy should be efficient and encourage more people and industries to participate in the program.

- Re-manufacturing—is the process of rebuilding a unit or machinery to restore its condition to "as good as new." This may involve reuse of existing components after overhaul, replacement of some component parts, and quality control to ensure that the remanufactured product will meet new product's tolerances and capabilities. The remanufactured product will normally come with a new product warranty. To make remanufacturing effective, the following steps are normally taken:

1. Collection of used items—This could be achieved through a recycling program where used or expired original products are collected from the customer and reshipped to the manufacturer. Some examples of these are drum and toner cartridges for computer printers and photocopying machines, auto parts, etc.

2. These items on receipt are inspected based on their material condition and a determination can be made on the economic feasibility of remanufacturing them.

3. Subsequently, the items are disassembled. If the full unit cannot be remanufactured, some components may be recovered for use in other components. Otherwise, the original item can be restored to a condition as good as new through repair and servicing. The recovery process must be efficient and focus on strategies that are conducive to the environment.

It is important that new products are designed for ease of disassemble and recovery of parts. This will make it more economical to conduct remanufacturing activities since it will be easier to determine which parts need repair or replacement.

This will also help in effective planning of the master production scheduling by minimizing the production planning time and parts inventory levels.

- Reverse logistics—requires that manufacturers take a "cradle-to-grave" approach of their products. This management of a product through its life cycle does not end with the transfer of ownership to the consumer and the expiration of warranty. Rather, the manufacturer is forever, responsible for the product. This is often referred to as "product stewardship." [Dillion and Baram 1991]. Roy and Whelan [1992] noted that this is a "systematic company efforts to reduce risks to health and the environment over all the significant segments of a product life cycle." Product stewardship is driven by public outcry about the degradation of the environment. This has led to new legislatures making manufacturers responsible for the residual effects of their product on the environment with no time limit. As a result, more and more companies are responding by developing environmentally responsible strategies. Some are also seeing that such strategies are good for business and may lead to competitive advantages. The concept of product stewardship as outlined by Roy and Whelan [1992] requires a focus on the following:

1. Recycling
2. Evaluation of equipment design and material selection
3. Environmental impact assessment of all manufacturing processes
4. Logistics analysis for the collection of products at the end of their lives
5. Safe disposal of hazardous wastes and unusable components
6. Communication with external organizations—consumer groups legislature, and the industry at large.

This focus is embodied in the reverse logistic strategy. It is a new way for manufacturers to view their products and develop a business model that could enable them to profit from developing a product stewardship approach. Obviously, by using remanufacturing strategy, the manufacturer can save significantly from the cost of labor and materials. Giuntini [1997], Note that about 10 to 15% of the gross domestic product could be affected, by adopting reverse logistic as a business strategy. Furthermore, about 50 to 70 percent of the original value of an impaired material can be recovered

from customers. In addition, the cost of sales (direct labor, direct material, and overhead) which currently, averages 65 percent to 75 percent of the total cost structure of a manufacturer can be reduced by as much as 30 percent to 50 percent through reverse logistics. He identified the by-products of reverse logistics as follows:

- Industrial waste throughout the manufacturing supply chain, would be reduced by as much as 30 percent
- Industrial energy consumption would be noticeably reduced
- Traditionally under-funded environmental and product liability costs would be better controlled and understood.

He suggested the following 10 steps for a manufacturer to implement a reverse logistics business strategy:

- Products must be designed for ease of renewal, high reliability, and high residual value.
- Financial functions must be restructured to cope with different cash-flow requirements and significant changes in managerial accounting cues.
- Marketing must reconfigure its pricing and distribution channels.
- Product support services and physical asset condition monitoring management systems must be implemented to manage manufacturer-owned products at customer sites.
- Customer order management systems must be implemented to recognize the need for the return of an impaired asset from a customer site.
- Physical recovery management systems must be implemented to manage the return of impaired physical assets.
- Material requirements planning management systems must be implemented to optimize the steps required to be taken upon the receipt of recovered impaired assets.
- Renewal operational processes must be established to add value to impaired assets.
- Re-entry operational processes must be established to utilize renewed assets.
- Removal processes must be established to manage nonrenewed assets.



- Eco-labeling—The aim of eco-labeling is to make consumers aware of the health and environmental impacts of products they use. It is expected that consumers will make the right decision and choose products that will have less environmental and health risks. By appropriately labeling the product and providing adequate product information for consumers to make the choice between alternative products, it is hoped that manufacturers will move towards developing environmentally conscious production systems. Eco-labeling as a strategy is therefore, intended to identify the green products in each product category. It could be perceived as a marketing strategy that is partly driven by legislatures and partly driven by consumers concern for the degradation of the environment. Many of the eco-labeling schemes are based on the life cycle assessment (LCA) of a product and take the "cradle-to-grave" approach by evaluating the environmental impacts of the product from the extraction of the raw material to the end of the product's useful life. However, some of the popular eco-labeling schemes do not take this approach. The German "Blue Angel" mark which is one of the best known eco-labeling schemes focuses on the environmental impacts of the product at disposal and the Japanese EcoMark focus on the contributions of the product to recycling Using Eco-labeling, (<http://www.uia.org/uiademo/str/v0923.htm>).

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different countries have different environmental policies and standards as well as different economic policies and standards.

However, market forces and not government laws and legislatures drive eco-labeling. We operate in a global environment and without a standardized eco-labeling scheme; the entire supply chain will be affected. It is clear that many producers in industrialized countries source their raw materials and parts from different countries. If a standardized eco-labeling scheme is not developed, the entire supply chain will be affected and it will be difficult to implement an eco-labeling scheme that is based on a cradle-to-grave approach. Furthermore, the changes we have observed in the market economy since the 1980s as a result of the total quality movement (TQM) and the subsequent development of the ISO 9000 series of product standards suggest that international standards on eco-labeling are not far from implementation. In fact, with the success of ISO 9000, the International Organization for Standards (ISO) has developed the ISO 14000 series of standards with a focus on guidelines and principles of environmental management systems. The technical committee (TC 207) charged with developing standards for global environmental management systems and tools, has environmental labeling as part of its focus. ISO 14020 deals with the general principles for all environmental labels and declarations [Madu 1998]. As expected, these standards will be widely adopted and when that happens, businesses will be expected to follow accordingly in order to compete in global markets. ISO already has classifications for eco-labeling schemes and the Type I eco-labels have the greatest impact on international trades. A third party to products that meet specified eco-labeling criteria grants certification. The issue is not to have each country develop its own plan for eco-labeling but, for world bodies such as ISO to institute a standardized scheme that will be cognizant of the limitations poorer nations may face. Indeed, ISO has four standards dealing with eco-labeling. These are ISO 14020, ISO 14021, and ISO 14024 and ISO 14025. Although ISO standards are voluntary, with the worldwide acceptance of ISO, it is expected that many companies and countries will work within the guidelines of these standards. Environmental protection should be a worldwide effort and without such an effort, the whole idea will be marginalized. Finally, some have argued that eco-labels do

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impacts of production or service activities from the product conception stage (i.e., raw material generation) to the end of the product's life (i.e., recovery, retirement or disposal of the product). Thus, the manufacturer is responsible for the environmental impacts of the product through different stages in its life cycle. Life cycle assessment often involve three major activities [Affisco 1998]:

1. Inventory analysis—this deals with the identification and quantification of energy and resource use as well as environmental discharges to air, water and land.
2. Impact analysis—is a technical assessment of environmental risks and degradation.
3. Improvement analysis—identifies opportunities for environmental performance improvement.

Notice also that several of the ISO standards listed in Table 1 deal with Life Cycle Assessment. Already, ISO 14040 on principles and framework and ISO 14041 on goal and scope definition and inventory analysis have been adopted as standards.

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2. Design for Remanufacture—This recognizes the different stages of equipment or product wears. For example, certain parts of machinery (i.e., auto parts)

could be recovered, remanufactured and restored to a state as good as new. Reusing them in newer products could further extend the lives of such parts. The challenge is how to design the original product for ease of recovery of those parts. We notice for example that newer computer systems are designed with the ease of upgrading them. Thus, new capabilities could be added to the system without having to dispose of the old unit.

3. Design for disposability—This recognizes the fact that many of the earth's landfills are filling up at an alarming rate. Further, many of the deposits are hazardous and unsafe. It is important to design the product with the ease of recycling and disposal. The final waste generated from the product should also be disposed safely.

## ***Chapter 4 Environmentally Conscious Manufacturing***

In Chapter 2, we introduced the concept of sustainable development and sustainable manufacturing. It is apparent that the goals of sustainable growth cannot be attained if we do not change our consumption pattern. Manufacturing plays a critical role in introducing new products to the market and also in shaping our tastes and consumption. Sustainable development cannot be achieved if adequate emphasis is not paid to sustainable manufacturing.

Environmentally conscious manufacturing (ECM) is often referred to as "ecofactory." The goal of ecofactory is to achieve optimal utilization of natural resources without harming the environment and without compromising the quality of the products. This goal can be achieved if effective utilization of natural resources is made, waste is minimized, and cradle-to-grave approach of the product is taken. In other words, the goal of ecofactory is not limited to the production process but spans through distribution, consumption and recovery and effective disposal of potential wastes. Thus, the manufacturer tracks and manages the whole product life cycle. Environmentally conscious manufacturing (ECM) as a strategy adopts a systemic approach to product development and distribution. This approach starts from the design stage of the product where every effort is made to ensure that the product is environmentally friendly to an environmentally responsible disposal of the product or its waste at the end of the product life cycle. Watkins and Granoff (1992), define environmentally conscious manufacturing as "those processes that reduce the harmful environmental impacts of manufacturing, including minimization of hazardous waste, reduction of energy consumption, improvement of materials utilization efficiency, and enhancement of operational safety." Through ECM, the aim is to achieve "zero waste" through total system integration of the entire production and distribution processes. A preventive approach to environmental protection that focuses on reducing waste at the source rather than at the end-of-the-pipe treatment is commonly adopted. Manufacturers develop products for ease of disassemble, recycling, and use non-hazardous and non-toxic materials. Some of the strategies for environmentally conscious manufacturing such as inverse manufacturing, recycling, reverse logistics, re-manufacturing, and others, were

briefly introduced in chapter two. In this chapter, we explore in greater depth some of the most commonly used strategies.

Reverse Logistics—also known, as reverse supply chain management has increasingly become popular among manufacturers. Have you ever wondered what manufacturers do with products that are returned by retailers? Well, this is the case of reverse logistics. Reverse logistics deals with the processing of goods that are returned from the customer's customer. The normal process for supply chain management involve the flow of goods and services to the consumer with little or no focus on the flow of waste back to the manufacturer. This is changing hence the term reverse supply chain management. The increasing cost of landfills, environmental laws and regulation and the economic viability of environmental strategies are pushing manufacturers to now consider reverse supply chain management. For example, localities are establishing new landfill regulations that often require separation and grouping of materials of the same type for ease of recycling. Recyclable items are no longer grouped together with all types of waste and garbage. Also communities are developing designated drop sites and manufacturers develop disposition processes. Some have also developed recycling programs for containers and cans with designated sites for ease of management of the recycled items. Here, the customer through a reverse chain returns goods to the manufacturer for effective disposal. For reverse logistics to work effectively, information management is critical. Manufacturers embarking on reverse logistics must be able to sort out salvageable items and separate repairable and non-repairable salvageable inventories. Effective management planning system that focuses on transportation planning, location analysis, and inventory control and management, and coordination of customer and vendor activities will be needed. Thus, it is important that in reverse logistics, not only does the product flow back to the manufacturer but also, information about the good that is being returned should flow back to the manufacturer. Manufacturers may be able to improve their bottom line if reverse logistics strategy is successfully implemented. However, before we continue, an important question in the context of environmental planning and management is why is reverse logistics an acceptable alternative to environmental protection?



Marien[1999], notes that manufacturers are developing source- reduction strategies as promising alternative to minimizing wastes and environmental pollution. This strategy is based principally on:

Reducing the weight and size of the product. This optimizes the logistics costs in both the supply chain and the reverse supply chain. Further, the cost of warehouse space is reduced as the size is reduced. Also, labor and material handling costs are significantly reduced when the item is trimmed in size and weight. Many organizations are embarking on this strategy. For example, the packaging industry is increasingly, achieving reduction in their packaging program. Sears for example, has reported a packaging reduction program that has saved 1.5 million tons in the supply chain which is a savings of about \$5 million annually in procurement and disposal costs [Marien, 1999]. Likewise, computer companies are increasingly building faster and more effective computers that are smaller in size and weigh less.

Minimization of production and distribution operations. There are many ways this could be achieved. First, minimizing production operation can be achieved by designing and building the right products that are highly dependable for the consumers. The high quality built into the product means that there will be less rejects, reworks, or returns. Thus, limited resources are optimally utilized and energy consumption is reduced. Further, by doing things right the first time, labor cost is reduced. With the high quality of the product, it becomes competitive and the organization gains. Distribution operation is also optimized when quality is built into the product. Clearly, the high return rate of products will be avoided thus reducing the high cost of distribution through the supply chain. Also, there will be less need for inventory of replacement parts and returned goods and

more efficient use of the distribution channel. The end result is that resources are optimally utilized and waste is minimized.

Reuse of materials and resources. The Eastman Kodak single- use-camera is the best example of this concept. However, there are many more examples. Computer components are easily recycled and many of the paper products used today are recycled. It is possible to reuse some of these materials as in the case of Kodak and Xerox

because they are designed for ease of disassembly. Thus, when a product is returned, it is easy to disassemble it, recover usable parts and integrate them in the production process. The concept of re-manufacturing is getting popular today because it is easier to recover useable materials from used equipment.

Another strategy is the substitution of materials that are environmentally friendly. This strategy is mostly utilized when a hazardous or toxic material is replaced with a more environmentally friendly substance. It could also be applied in conserving resources that are very limited in supply. One example is the replacement of the use of DDT (dichloro- diphenyl-trichloro-ethane) as a pesticide. DDT is a chlorinated hydrocarbon and it is not easily biodegradable. When used, it can be found in the tissues of living organisms that are exposed to it. It also has a disastrous influence on marine life as it reduces the rate of photosynthesis in marine phytoplankton, which is the base for most marine food chains. Since humans are at the end of this food chain, they can suffer irreparable health conditions from deposits of DDT in their tissues. Another example is the worldwide ban of the use of CFCs, carbon tetrachloride, and methyl chloroform. The U.S. Clean Air Act of 1990, outlawed these chemicals in the year 2002. CFCs are normally used as coolants and were once common in home refrigerators but are also ozone depleting. Manufacturers such as DuPont have already replaced CFCs with hydrofluorocarbon (HFC) called HFC-134a. This new product is nonflammable, non-toxic, and non-ozone depleting, and has the same energy efficiency as CFCs.

### Why Reverse Logistics?

There is limited landfill space available for dumping of wastes. Also, landfill is becoming increasingly more expensive to manage. Many organizations are realizing that reverse logistics offers the opportunity to recycle and reuse product components while cutting down the cost and the amount of waste that will normally be incurred. In Chapter 2, we presented a case of Kodak single use camera, which follows a reverse logistic strategy. We noted that in the U.S., a 63 percent return rate has been achieved for recycling. This is equivalent to fifty million SUCs or enough SUCs to fill up 549 tractor-trailer loads. Imagine the landfill requirement for disposing of waste of such an

enormous quantity. Not only was waste avoided, Eastman Kodak improved its bottom-line by recycling and reusing components from returned SUCs and also, reduced the cycle time for re-introducing the product into the market. While the strategy is environmentally responsible, it is also economically profitable. Eastman Kodak is not alone. Many other organizations are adopting reverse logistics. Hewlett-Packard for example refill returned printer toner cartridges and Xerox recovers used machines from customers and use them to remanufacture new ones. These actions have reduced the demand for landfill, reduced the need for excavation of new raw materials, and have reduced energy consumption from the processing and manufacturing of virgin products.

New environmental laws and regulations are clear in assigning responsibilities to manufacturers. Manufacturers must now take full responsibility of their products through the product's life cycle, or they may be subject to legal action. For example, new laws regarding the disposal of motor or engine oil, vehicle batteries and tires assign disposal responsibility to the manufacturer once these products have passed their useful life. Thus, as Marien [1999] notes, to avoid the related supply chain complexity, it is important for manufacturers to build reusability into their products. Thus, manufacturers act by developing infrastructure to handle post-distribution and consumption activities. Hence, reverse logistics is increasingly seen as a competitive strategy that is not only designed to meet the social responsibility function of the firm but also designed to make the organization more profitable. Marien [1999] points out that the savings accruing to organizations that adopt reverse logistics are in the form of savings from "raw material and packaging procurement, manufacturing, waste disposal, and current and future regulatory compliance."

Businesses look at their bottom-line. Ultimately, the goal of environmental protection cannot succeed without the participation of business organizations. For their cooperation and participation in environmental programs to be assured, there must be potential benefits to them. In the past, businesses use to view environmental protection efforts as wasteful expenditure but not any more. They are now seeing that environmental programs offer competitive advantage. More consumers pay attention to the environmental friendliness of the products they purchase. Also, organizations are

beginning to realize that environmental strategies such as reverse logistics can cut down drastically on production and operations cost thus improving their profit margins. Some of the costs incurred from reverse logistics include the costs of refuse, reworks, recyclables, rejects, reprocessed overruns, reuse, remake, redo, residues, reorder, resale, returnable shipping containers and pallets. However, some of these costs are controllable. For example, the cost of rejects, reworks, and reprocessing can be avoided if the organization adopts a quality imperative. Thus, reverse logistics operates efficiently when the organization adopts other comparative strategies such as developing an effective quality program. Also, the benefits of reproducing a product from recyclable items may far exceed the costs associated with reverse logistics. Some of these costs such as the cost of disassembles could be seen as production costs since they replace the traditional costs of production. However, the organization can become more effective by designing its products for ease of assemble and also, by developing an efficient reverse supply chain network.

There are several logistical problems involved with reverse supply chain network. For example, what is the cost of transporting the goods back to the manufacturer? How often can the goods be returned? Is it better to use decentralized or centralized reverse logistics strategy? What is the cost of inventory? And what is the cost of processing the returns? To address some of these issues, Bunn [1999] presents factors for consideration in developing centralized logistics strategy. These factors focused mainly on costs relating to store labor processing, transportation, inventory, opportunity costs, credit terms, and operating cost of a centralized facility. These factors may come into play in negotiating better terms with vendors. By using the right logistics strategy, costs can be significantly reduced. However, each operation is different and it is important to take its uniqueness into perspective in determining the correct reverse logistics strategy.

### Recycling

Recycling is a process of converting materials that could have been treated as wastes into valuable resources. There are many examples of recycling such as aluminum cans, bimetal cans, glass bottles, newspapers, paper products, and composting. Recycling is one of the better-known strategies for environmentally

conscious manufacturing. In fact, the concept of recycling is vogue today as many communities have adopted recycling programs. In these areas, recyclable materials are carefully separated from ordinary garbage or waste and the garbage collectors make a distinction between recyclable materials and garbage when they schedule pickups. Recycling is considered an environmental success story of the 20th century. As the United States Environmental Protection Agency (EPA) reports, recycling including composting has contributed to a significant reduction in the amount of material being turned over to landfills and incinerators for disposal [downloaded 11/8/99, pp. 1-4]. Based on this account, in 1996, 57 million tons of material that would have been sent to landfills and incinerators as garbage were recycled. This amounts to a 67% increase from the 34 million tons that were recycled in 1990. Likewise, the number of curbside collection programs in the United States has increased dramatically. There are reasons for the success of recycling:

Consumers are increasingly concerned about the depletion of earth's limited resources and are also worried about the degradation of earth's environment through landfills, excavations, destruction of forestry, and pollution of air, water and land. They are therefore, willing to participate in protecting the environment. It is their cooperation that has attributed to the great successes of recycling programs. Consumers are now buying recycled products and investing in companies that market recyclable products.

Recycling is profitable. Many organizations are now realizing that they can cut down on cost of material, reduce the cycle time for introducing new products, reduce processing time, and even become more efficient in their planning process if they recycle and reuse their products. They have better control of their recycled products and may avoid complex supply chain networks associated with dealing with vendors for virgin products who are outside their control.

Environmental laws and regulations that require that certain types of products be recycled have also contributed since the penalty for non-compliance may at times be severe. Apart from the legal ramifications of non-compliance, environmental activist groups can also damage the reputation of non-complying companies thus contributing to high customer dissatisfaction with the company and its products and services. • Apart

from the profitability of recycling programs to organizations, consumers benefit directly. For example, another form of recycling is composting. Composting is the recycling of organic wastes. Many of the organic wastes can be easily recycled such as food and yard wastes and can be fed back to soils or applied in landscapes. Such applications help reduce plant diseases and provide nutrients to soil. Further, some of the beneficial soil organism such as worms and centipedes feed on such wastes.

Palmer [2000] gave a detailed discussion and definition of recycling and also identified the conflicts in current recycling programs. Noting that we live in a world endowed with finite resources, it is important to articulate and develop resource policy that can help achieve sustainable development while protecting the environment. Although this is often difficult to achieve due to several pressures on national economic programs that for some countries, often demand exploitation of these limited natural resources to generate needed capital however, it is imperative that national planning issues focus also on the needs of the future generation. Such focus will help to seek for example better alternatives to the use of landfills and encourage recycling policies that are environmentally friendly. For example, prior to recycling, all "wastes" were grouped as the same and are dumped in designated dumping sites for wastes. When a landfill has been used up, a new one is created and this process goes on and on. Little did the general public know that apart from the unsightly image of the landfill and the unbearable odor gasping out from it, it could also become a health hazard. Forty percent of the Superfund sites are municipal garbage dumps [Palmer, 2000], since all sites were for management of toxic wastes, disposal of chemicals and other hazardous wastes. For example, approximately one-third of GM 's toxic release inventory to landfill from foundry waste used to contain zinc. A new plan by GM will eliminate these land releases from GM foundries by the year 2002 [Annual report, 1997], In 1997, GM recycled 61 percent of all these wastes. Furthermore, the separation of wastes into "recyclables" and "non-recyclables" has contributed immensely to sustainability. First, there is lesser need for landfills since the amount of wastes designated for dumpsites have declined. Second, recyclable items have extended lives and are re-used in the manufacturing and production processes. This use decreases the need for new or virgin

products similar to the recycled item. Third, there is less need for energy consumption. As treated equally then, toxic compounds and chemicals were equally mixed with other wastes. This has been attributed to many of the environmental degradation, destruction of wildlife, and health problems. Thus, it became clear that these "wastes" needed to be separated especially from their sources.

Although recycling can help conserve resources and save energy, not all materials are easily recycled. For example, cadmium and beryllium are not easy to recycle. Cadmium is widely known to the general public for its use in batteries. Its application in nickel-cadmium (Ni-Cd) batteries is one of the easiest forms to recycle. Many other applications of cadmium are in low concentrations and are difficult to recycle since much of the cadmium is dissipated. However, the growing application of cadmium in batteries and the concern about potential environmental pollution has led to regulations limiting the dissipation of cadmium into the ground [1997]. Moreover, Beryllium is also difficult to recycle and it is widely dispersed in products when it is used in manufacturing. It also dissipates and is very difficult to recycle.

#### Inverse Manufacturing

Inverse manufacturing has its roots from Japan where it began as a reuse and recycle project. The concept of inverse manufacturing is an extension of the recycling, reuse, and remanufacturing concept. It focuses on the pre-manufacturing process especially at the product design stage. The aim is to prolong the useful life of the product through design by designing reuse and recycling features into the product. The other feature is to design the product so that it is easy to disassemble. One way this is accomplished is by building modules into a product. For example, computers and refrigerators are made up of modules. These modules can be upgraded or replaced without replacing the entire product. For example, the functions of a personal computer can be upgraded by replacing modules such as the central processing unit (CPU) [1996]. In addition to these attributes, inverse manufacturing focuses a lot on maintenance. It envisages leaner manufacturing where companies will have to do away with the concept of mass production by creating quality products that will last longer. This vision will require transformation of many of the manufacturing outfits into life cycle companies

with a focus on providing maintenance services on their products. The construction industry is actually an industry that survives well by providing mostly maintenance services on existing infrastructures. Through inverse manufacturing, product manufacturers can in fact, transform themselves to life cycle companies by providing maintenance operations and services to their products, thereby prolonging the useful life of the product. Why this concept may seem radical, it may be a desired option given the increasing problem with landfills and the limited natural resources. This closed-loop product life cycle approach leads to minimal disposal and environmental costs. According to the Inverse Manufacturing Forum Secretariat, inverse manufacturing takes a reverse process approach by focusing on the recovery of the product to disassembling to reutilization and production. This gives a complete loop of the product life cycle.

The concept of inverse manufacturing also requires a cultural transformation. The general society must be educated on the need to maintain products rather than discarding or dumping them in landfills.

Further, manufacturers should also educate their customers and support the initiative to prolong the lives of these products. One factor that worries some about inverse manufacturing is that the decline in mass production may lead to loss of job as production capacity is decreased. However, the transformation to life cycle industry may absorb the excess capacity that may result from the decline in production.

In sum, inverse manufacturing involves the following:

Integration of reuse and recycling plans at the early stages of product design,

Emphasis on product maintenance and reduction in production volume through transformation to life cycle industry, and

Modular design strategies to make it possible to expand and upgrade product functions. Hata [1997] presents a good framework on inverse manufacturing. An adapted version is presented below:



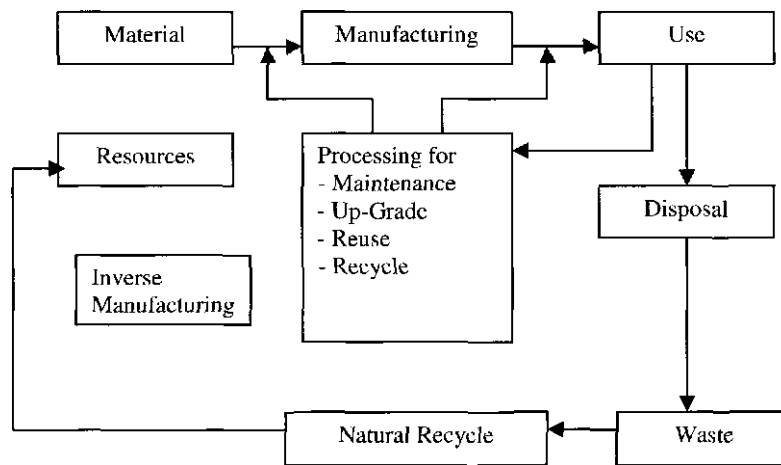


Figure 4.1: Product Life Cycle based on Inverse Manufacturing

### Remanufacturing

Remanufacturing is the process of rebuilding a product from ground up utilizing new parts to return it to a condition "as good as new." This involves disassembly of each component in a product, inspection and testing of parts, evaluation of components for quality and reliability standards, replacement and upgrade of parts. Remanufactured parts possess some important attributes such as

The appearance of the product is refurbished and enhanced

Quality and reliability standards are satisfied

Performance is guaranteed

They are economical and environmentally friendly.

Remanufacturing is different from refurbishing where many of the changes are cosmetic involving rehabilitation of an older product to provide services, retrofits and upgrades. Refurbishing does not undergo the extensive process of remanufacturing a product to ensure that it is returned to a condition that is "as good as new."

### Design for Environment

The strategies discussed above consequently lead to the design for the environment. A combination of strategies must be followed in order to achieve an improvement in environmental performance. These strategies include raw material acquisition, product design, product usage and disposal. At each stage of the product life cycle, attention must be paid on how to conserve and effectively use resources. Pollution prevention and waste minimization become the driving force of strategies for

designing for the environment. The product design stage pays tremendous attention on how limited resources are used, explores the use of replenishable materials and the use of substitute products to prevent pollution problems, and considers the energy demands of the product. The product design stage is critical in environmental management since problems uncovered at this stage can spread through the product life cycle and create more environmental hazards. It is at the product design stage that the decision to design for recyclability is made. If the product is not effectively designed to be easily disassemble and for component recovery or for material separability to avoid contamination, it will be difficult to treat this problem later on. Thus, a strategy at this stage to design for recyclability can help in minimizing both material and energy wastes and ensuring the conservation of limited resources. This strategy of designing for recyclability is also closely linked to the design for remanufacture. When components can be easily recovered from a malfunctioning unit, they could also be equally remanufactured, restored and reused. The extension of a component's life cycle also implies that there will be less demand for landfills for disposal of old units and there will also be less need for virgin products. These strategies therefore supplement each other. When a product is effectively designed for recyclability, it will meet the remanufacturing needs and its disposal needs.

## ***Chapter 5 The ISO 14000 Model***

In this chapter, we shall discuss some of the most important standards for environmental management systems. Such standards are embodied in what is now known as ISO 14000 family of standards. These are set of standards and guidelines that could help businesses to develop more environmentally friendly products and services. ISO standards have received worldwide attention primarily because of the reputation of ISO (International Organization for Standardization) itself. The origins of ISO dates back to 1947 when it was formed as an NGO (non-governmental organization) with the purpose of promoting the development of standards to facilitate the international exchange of goods and services. ISO seeks international cooperation in scientific, technological and economic activities. Its membership has grown to over 100 countries that are represented by their national standards organization. The term ISO is derived from the Greek word 'isos' which means 'equal.' This can explain the goal of ISO to develop "equal" standards to guide the international exchange of goods and services. International standardization of goods and services protects the consumer and may also facilitate the transfer of technology and trade. Some of the benefits are in :

- Enhanced product quality and reliability at reasonable price;

- Improved health, safety and environmental protection and reduction of waste;

- Greater compatibility and interoperability of goods and services;

- Simplification for improved usability;

- Reduction in the number of models and thus reduction in costs;

- Increased distribution efficiency and ease of maintenance.

In today's global economy, there is a need for standardization both in product quality and environmental content. With uniformity in standards among similar industries and technologies, companies can compete on a level playing field by removing some of the technical barriers to trade. However, achieving some of the standards may in the short-run become very costly and may make it difficult for some poorer nations to participate effectively in global markets.

The ISO successfully developed the international standards on quality assurance techniques and practices in the 1980s. These standards known, as ISO 9000 series of standards for product quality got worldwide acclaim and has fueled the development of a new set of standards for environmental management systems.

#### ISO 14000 Series

The ISO 14000 series of standards represent new sets of standards on environmental quality issues. They deal with guidelines and principles of environmental management systems to make businesses to focus on the growing need of environmental protection. The concept of ISO 14000 was introduced by a team of 50 business executives interested in sustainable development and known as the Business Charter for Sustainable Development (BCSD). By 1992, the world was increasingly concerned about the increasing pollution of the natural environment. The Earth Summit conference on Environment and Development was organized by the United Nations and held in Rio de Janeiro, Brazil in response to these concerns. ISO then formed the Strategic Advisory Group on the Environment (SAGE) and charged it with the evaluation of the international standards on environmental management systems. SAGE's recommendations in 1993 led to ISO 14000. Technical committee (TC) 207 was then formed to replace SAGE. This committee has the responsibility to develop standards for global environmental management systems and tool. The committee was to focus on the following areas of environmental management systems:

- Environmental management systems (EMS);

- Environmental auditing;

- Environmental labeling;

- Environmental performance evaluation (EPE);

- Life cycle assessment;

- Terms and definitions;

- Environmental aspects in product standards (EAPS).

By the third quarter of 1996, the committee completed its work and published a series of standards to help firms manage and evaluate the environmental aspects of their

operations. In Tables 5.1, we present the ISO 14000 family of standards and their applications. This table is adopted from the ISO web site (<http://www.iso.org>).

Table 5.1: ISO 14000 Series Standards

Standard number	Title
ISO 14000	Environmental management systems — general guidelines on principles, systems and supporting techniques
ISO 14001	Environmental management systems — specifications with guidance for use
ISO 14004	Environmental management systems — general guidelines on principles, systems and supporting techniques
ISO 14010	Guidelines for environmental auditing — general principles of environmental auditing
ISO 14011	Guidelines for environmental auditing — audit procedures — part 1: auditing of environmental management systems
ISO 14012	Guidelines for environmental auditing — qualification criteria for environmental auditors
ISO 14020	General principles for all environmental labels and declarations
ISO 14021	Environmental labels and declarations — self-declaration environmental claims — terms and definitions
ISO 14022	Environmental labels and declarations — self-declaration environmental claims — symbols
ISO 14023	Environmental labels and declarations — self-declaration environmental claims — testing and verification
ISO 14024	Environmental labels and declarations — self-declaration environmental claims — type I guiding principles and procedures
ISO 14031	Environmental management — environmental performance evaluation guideline
ISO 14040	Life cycle assessment — principles and framework
ISO 14041	Life cycle assessment — inventory analysis
ISO 14042	Life cycle assessment — impact assessment
ISO 14043	Life cycle assessment — interpretation
ISO 14050	Terms and definitions
ISO 14060	Guide for the inclusion of environmental aspects in product standards

There have been significant changes in the ISO 14000 series of standards since 1996. Updated lists at different stages of development are presented in Tables 5.2 and 5.3 below.

The process for adopting a standard is briefly discussed so that the reader can see from the prefixes attached in the tables below, the status of a particular working document.

Before a committee's draft is accepted as a standard, it must be approved following a consensus process. Briefly, the following steps are taken:

A working draft (WD) is developed by a work group (WG) and WG members may share the WD within their own countries.

Comments received from participating WG members are used to revise the WD which can again be shared within each WG member's country. This procedure is followed until a consensus is reached by the WG members on the WD.

The WD is then presented to the subcommittee (SC) to be accepted as a committee draft (CD). Subcommittees are responsible for developing the standards within a defined area.

The CD is distributed to all SC members as a CD for ballot on four options as follows: Approve as is as a draft international standard (DIS); approve as a DIS with comments; disapprove the CD as a DIS; and abstain.

If two-thirds of the returned ballots approve the CD as a DIS as is and/or with comments, it is elevated to a DIS.

The DIS is forwarded to technical committee members after necessary revisions have been made and the members may approve or disapprove it as an ISO standard.

If approved, all necessary editorial changes are done and a final ballot is taken on the revised DIS now refereed to as final or FDIS. Passage of this final ballot results in an ISO standard.

In Table 5.2, we present the EMS standards as of today based on the revisions of 2004. We also attach the most recent dates associated with each standard.

Environmental Planning and Management  
Table 5.2: ISO 14000 Series of Standards

Standard number/Date	Status
ISO 14001, 2004	International Standards
ISO 14004, 2004	International Standards
ISO 14010*	International Standards
ISO 14011*	International Standards
ISO 14012*	International Standards
ISO 14021, 1999	International Standards
ISO 14020, 2000	International Standards
ISO 14024, 1999	International Standards
ISO 14041, 1998	International Standards
ISO 14031, 1999	International Standards
ISO 14042, 2000	International Standards
ISO 14043, 2000	International Standards
ISO 19011, 2002	International Standards

\*ISO 19011 on environmental management systems auditing replaces ISO 14010, ISO 14011, and ISO 14012 on guidelines for quality and/or environmental management system auditing.

Table 5.3 contains other proposed EMS standards at different stages of development. It is presented below:

Table 5.3: Working Documents on EMS Standards (Table is adapted from <http://www.tc207.org/pdf/ISO14000series1.pdf>)

Standard number/Status/Date	Description
ISO/TR 14025, 2000	Environmental labels and declarations. Type III environmental declarations.

ISO/DIS 14025	Environmental labels and declarations. Type III environmental declarations. Principles and procedures.
ISO/TR 14032, 1999	Environmental management - Examples of environmental performance (EPE)
ISO/DIS 14040	Environmental management - Life cycle assessment - Principles and framework.
ISO/DIS 14044	Environmental management - Life cycle assessment - Requirements and guidelines.
ISO/TR 14047, 2003	Environmental management - Life cycle impact assessment - Examples of application of ISO 14042.
ISO/TS 14048, 2002	Environmental management - Life cycle assessment - Data documentation format.
ISO/AWI14048	Environmental management - Life cycle assessment - Data documentation format (Revision of ISO/TS 14048:2002).
ISO/TR 14049, 2000	Environmental management - Life cycle assessment - Example of application of ISO 14041 to goal and scope definition and inventory analysis.
ISO/NP 14050	Environmental management - Vocabulary.
ISOATR 14061, 1998	Information to assist forestry organizations in the use of EMS standards (ISO 14001 and ISO 14004).
ISO/TR 14062, 2002	Environmental management - Integrating environmental aspects into product design and development.
ISO/DIS 14064-1	Greenhouse gases - Part 1: Specification with guidance at the organizational level for quantification and reporting of greenhouse gas emissions and removals.
ISO/DIS 14064-2	Greenhouse gases - Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.
ISO/DIS 14064-3	Greenhouse gases - Part 3: Specification with guidance for validation and verification of greenhouse gas assertions.
ISO/WD 14065	Greenhouse gases - Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition.

Definitions: DIS - Draft International Standard; TR - Technical Report; TS - Technical Specification; AWI - Approved Work Item; WD - Working Draft; and NP - New work item Proposal.



ISO 14001 is considered the core standard because it is the only standard with specified requirements that firms must meet in order to achieve certification. A firm can therefore be audited on ISO 14001 standards. All the other standards listed in Table 4.2 are guidelines to help implement ISO 14001. These standards are not required for certification and a firm may not be audited on their basis. We shall briefly discuss the core areas covered by the ISO 14000 standards.

### Environmental Management Systems (EMS)

The core elements of an environmental management system (EMS) are presented in ISO 14001. The core consists of requirements that a firm can be audited on for certification. It deals only with environmental management standards and does not consider performance issues. To help implement EMS, ISO 14004 offers general guidelines on principles, systems and supporting techniques.

The involvement of top management is necessary when developing an environmental policy. The environmental policy must consider the environmental impacts of the activities, products or services of the firm. Management must be committed to continuous improvement efforts, and develop and implement plans for pollution prevention. It is important for management to ensure compliance to environmental legislation and regulations, and also to other regulations that the firm may already be committed to. This may involve establishing communication links with various interest groups. There must be an established framework to review environmental objectives and targets and the environmental goals of the firm must be documented and effectively communicated to all employees. The public should also be made aware of the environmental policy of the firm. Thus, top management has the responsibility of making the public aware of its environmental policy.

### Planning

A firm must develop a plan to help it achieve its environmental policy. Components of the plan are environmental aspects; legal and other requirements; environmental objectives and targets; and environmental management programs. Environmental aspects deal with procedures that the firm maintains to identify the environmental aspects of its activities, products or services. The firm makes an

assessment of these impacts and determines its control over them and their expected impacts on the natural environment. The significant impacts must be considered in setting up environmental objectives. This information should be updated over time. It is a dynamic process that requires the firm to continuously monitor its environmental influence and impacts on the natural environment and update the available information as needed.

With regards to legal obligation and other requirements, it is the responsibility of the firm to be aware of the legal requirements it must comply with. It should maintain procedures to enable it to access such obligations that are applicable to the environmental aspects of its activities, products or services.

The firm must have environmental objectives and targets. These should be consistent with the environmental policy and commitment to pollution prevention. It is important that documentation is maintained at each relevant function and level within the organization. The objectives and targets should be cognizant of the legal and other requirements that the firm subscribes to, its significant environmental aspect, its technological options, financial, operational and business requirements as well as the views of other environmental interest groups. The targets should be measurable and specific and may be used to achieve the environmental objectives within a specified time-frame. Environmental management programs are the operational procedures to achieve environmental objectives and targets. They involve a breakdown of responsibilities for achieving objectives and targets; actions to be taken; resource allocation; and time-frame.

### Implementation and Operation

To effectively implement the environmental management program, the firm must develop the necessary capabilities and support mechanisms. This involves a well-structured organizational process where job responsibilities and authorities are well defined, documented and communicated. Resources needed to implement the program must be provided and management must be involved to ensure system viability and assess the performance of the program. A major aspect of implementation and operation

of the environmental program is training awareness and competence. Competence may be developed through education and training.

It is important that trainees are aware of the requirements of the system and potential consequences of departure. Thus, appropriate training should be available. Communication is also an important aspect of implementation. The firm should have procedures for responding to relevant communications from external interest groups; and procedures for both internal and external communications. Like in many of the ISO standards, documentation is very important and could be either in paper or in an electronic form. However, there must be full document control procedures. Implementation must also deal with operational control of activities that are done under specified conditions. Suppliers and contractors should also be made aware of the procedures of the firm. The firm should have procedures to respond to emergency situations. This involves plan to respond to emergencies and procedures for accident prevention. These plans should be revised when an incident occurs and should be periodically tested.

#### Checking and Corrective Actions

This step requires the firm to be able to measure, monitor and evaluate its environmental activities. This requires the firm to be able to monitor and measure key measures of performance, track operational performance, operational controls and objectives and targets. The monitoring process is only effective if the program complies with laws and regulations. Corrective and preventive actions may also be necessary when there is non-conformance. Auditing is conducted to assess conformance and proper implementation of procedures. A report is made available to management for review.

#### Management Review

This requires the firm to review and continually improve its environmental management system in order to improve the overall environmental performance. Periodic review by management will ensure suitability, adequacy and effectiveness; address the need for policy changes or any other changes of the environmental management system; and documentation of the review.

We shall now focus on the other aspects of the ISO 14000 series.

### Environmental Auditing

This provides the standards that may be used for environmental auditing of the firm. ISO 19011 offers the general principles for environmental auditing. This standard deals mainly with the objectives and scope of the auditing, professionalism of the auditor, procedures, criteria, reliability and reporting.

It is the firm that commissions the auditing and states the scope and objectives of the auditing. Auditors however, are expected to be fair and avoid conflict of interest. They must also have the required professional skills and experience to enable them to fulfill these important responsibilities. Information obtained from auditing and the resulting report should be kept confidential unless the firm approves disclosure. Auditors must also follow documented and well-defined methodologies to carry out their auditing of a firm's environmental program. There must be consistency of auditing reports. In other words, other competent environmental auditors should be able to independently, reach the same conclusions. Auditors should also recognize that they are working with sample information and must therefore include some levels of uncertainty in their audits. All auditing findings should be communicated in writing to the firm.

### Environmental Labeling

The aim of environmental labeling is to reduce the environmental impact that may be associated with the consumption of goods and services. This serves several purposes:

Labels are used to provide information on the environmental impact of a product or service and the consumer is made aware of that.

The information content of the label may affect the purchasing behavior of the consumer.

When purchasing behavior is influenced by the information content of the label, market shares may subsequently be affected.

This will affect the attitude of manufacturers or firms who will respond to consumers' needs if they intend to remain competitive and increase their market share.

There will be fewer burdens associated with the product or service.

## Environmental Performance Evaluation

This deals with a measure of performance. The ISO Sub Committee (5C4) defines it as a process to measure, analyze, assess, report, and communicate an organization's environmental performance. It is intended as a tool that assists company management in understanding environmental performance; determining necessary actions to achieve environmental policies, objectives, and targets; and communicating with interested parties.' (Block, 1997, p. 17). EPE focuses on three major areas: management systems, operational system and the environment. The management systems aspect deals with peoples' management. People within the organization take actions that may have an impact on the environment. There is a need for procedures and practice guidelines that relate to the management of the organization's environmental aspect. Operational system deals with process management. Here, the emphasis is on the transformation process to produce goods and services. Attention is given to the process itself in terms of equipment and physical structures and the materials and energy that are used to produce goods and services. The environmental emphasis is to focus organizational attention on its potential impact on all aspects of the natural environment. The organization is to assess the influence of its management and operational system performance on the environment.

## Life Cycle Assessment

The emphasis here is to evaluate manufacturing efficiency. Inventory analysis is employed to compile relevant inputs and outputs of a production system.

## Terms and Definitions

The aim is to co-ordinate the terms and definitions used by the various sub-committees and their work groups.

## Competing through Environmental Management Systems

Clearly, businesses are paying attention to ISO 14000 series of standards. Adherence to these standards can help an organization to be more competitive and increase its market share in a market environment that is increasingly focusing on 'green' products. The Standards Council of Canada (1997) in its publication provides a

list of reasons why many companies are interested in adopting an internal environmental management system. These reasons are:

- Reduction of liability/risk;

- Improvements of a company's image in the area of environmental performance and compliance with regulatory requirements;

- Pollution prevention and energy/resource savings;

- Insurance companies' unwillingness to issue coverage for pollution incidents unless the firm requesting coverage has a proven environmental system in place;

- Better resale value of a company's property assets;

- Desire to profit in the market for 'green' products;

- Improved internal management methods; and

- Interest in attracting a high-quality work force.

These factors serve as a motivating force for companies to adopt the standards. We must also add that increased consumer awareness and the activity of environmental interest groups have greatly influenced attention on the environment. Consumers are now concerned about the environmental quality of the product and purchase decisions are influenced by environmental issues. It is a business and marketing strategy for organizations to achieve certification in environmental management system to show their responsiveness to environmental management.

#### Revisions of ISO 14001

ISO 14001 which is the core of EMS was originally adopted in 1996 but was revised and adopted in 2004. The revision was intended to make ISO 14001 more user friendly by clarifying some of the statements in the 1996 document. It was also aimed to align ISO 14001 to the popular quality standards ISO 9001 and to establish clear association between the different segments of EMS, performance measurement, and the role of top management. This greater focus on alignment with ISO 9001 highlights the importance of quality imperative by emphasizing on Deming Plan-Do-Check-Act and continual improvement efforts. The revision also removed some of the vagueness in the original wordings of ISO 14001 by being specific on how some organizational

environmental goals may be achieved. Munro and Harral [2006] classified these revisions into five "interpretative paradigm differences" as follows:

- Communication - This deals with getting everyone on board to achieve the organizational environmental goals. They note that the greatest challenge is the increased detail that must be communicated to top management. The inclusion of "internal" communication in addition to external communication is emphasized.

- Documentation - There are changes in definitions, scope, and documentation requirements. Some of the definitions were borrowed from ISO 9001:2000. For example, organizations need to show that their auditors are competent. This concept of competence of auditors is derived from ISO 9001: 2000. Also, more succinct definitions of continual improvement and EMS audit are presented. Documentations have also been prepared to be easy to understand and also to demonstrate the significance of environmental aspects. There should also be documentation of results of periodic evaluations and monitoring of compliance.

- Competence - The definition of competence is still a gray area. Competence may vary from situations and challenges but organizations need to demonstrate by defining measures of competence. This could play major role not only in environmental auditing but may have labor and legal implications since competence extends to anyone that performs a task for the organization or rather, the entire value chain of the organization. The need for independent auditors is also emphasized.

- Performance focus and evidencing - The emphasis here is on measurement of objectives and targets and the need to see continual improvement as a "recurring" process and not a one-time thing. Resources must be readily available to support environmental goals.

- Legal and other requirements - There is need for a new level of awareness and this would require additional resources. There should be added emphasis on policy, objectives, or targets with resources devoted to them.

### Implementing ISO 14001

As we mentioned above, ISO 14001 is the core standard and it is the only standard that a firm can be audited on for certification. We also listed and briefly

discussed the four core elements of ISO 14001 as environmental policy, implementation and operation, checking and corrective action and management review. In order to implement ISO 14001, an organization must go through these elements in a step-by-step procedure. These core elements are actually motivated by the Shewhart Cycle popularized by Dr W. Edwards Deming and now widely known as the PDCA (plan-do-check-act) cycle. The PDCA cycle is commonly used in implementing quality management programs. We shall use this cycle to show how these core elements of ISO 14001 can be implemented.

Plan — the planning stage requires the organization to develop an environmental policy. The environmental policy is akin to developing a mission statement that will detail the organization's roles, objectives, goals, and vision with regards to environmental performance. The objectives and targets specified in this statement must be realistic and achievable with the resources dedicated to attaining the environmental policy. Environmental policy is the motivating force of the organization's environmental management system. The organization however can only plan when it has relevant information. It needs to know its history, the nature of its business, and the mode of its interaction with the natural environment through its organizational activities. Thus, there is a need to have information and knowledge on 'environmental aspects.' The environmental impact of the organization's activities on the natural environment should be estimated, considered and used in setting environmental objectives and goals. The business or organization must also know the legal and regulatory requirements that guide its operations and how it is expected to comply with them. With this knowledge base and top management commitment, achievable objectives and targets can be developed and appropriate resources devoted to their attainment.

Do — this involves implementation and operation. Once the environmental policy is known, it is broken down into actions to be taken and responsibilities duly assigned to members of the organization. Necessary training is offered to sensitize and make members of the organization aware of the environmental policy, and to develop the needed competence on environmental management issues. They are also trained and

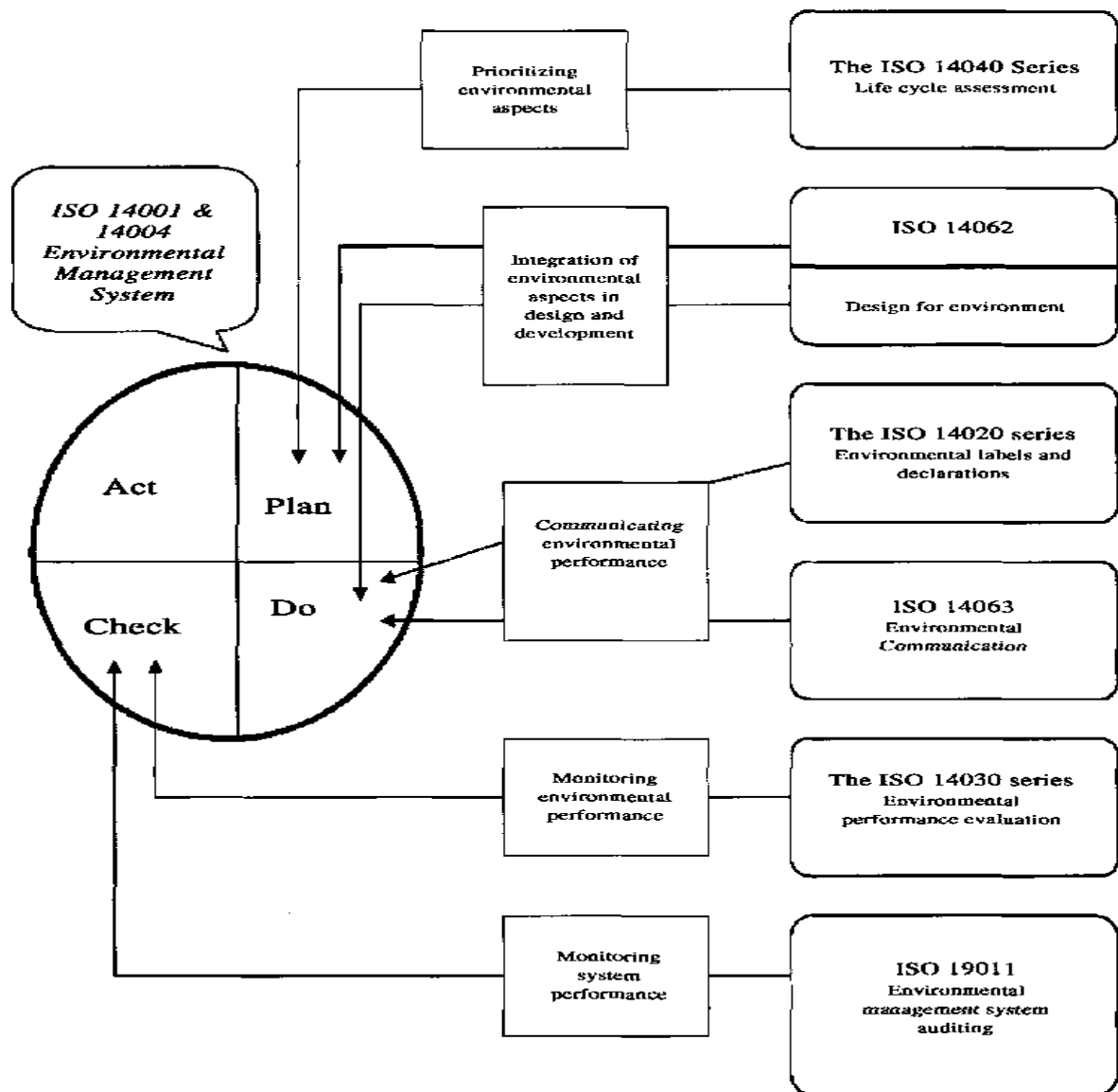


made aware of the need to document their procedures. Emphasis is also placed on operational control and emergency preparedness and response.

Check—Act — the check stage involves monitoring the entire procedure and obtaining feedback. In the EMS document, it is referred to as checking and corrective action. The essence of this step is to evaluate outcomes of key performance measures and see if they meet expected standards or targets. The monitoring is done on a regular basis so that deviations from expected targets can be detected early. The targets or standards may be based on compliance required by existing legal and regulatory requirements. When the system is detected as not meeting these standards, corrective actions can be taken promptly. The compliance requirements are part of the environmental policy so there is a target to aim for. The act stage is included in this step because actions are taken as the situation may warrant solving impending problems such as system's deviation from expected norm.

The fourth core element of ISO 14001 is management review. This requires top management to be involved as an active participant of environmental management system. This is necessary, because certain actions or decisions can be taken at the top management level. Top management is required to review the EMS to ensure its continuing suitability and effectiveness. This review may lead to changes in environmental policy. For example, the original policy may not be adequate given some organizational transformation or process changes that may have taken place or it may not have been effective. Management will then require a revision of the environmental policy or development of new environmental policy that will align with corporate objectives and goals. The environmental policy drives the EMS and the organization's overall environmental performance so it is important that top management takes charge of this step. Once this step is completed, the process continues.

The implementation process offered here is generic and does not relate to any specific industry. It is a stepwise procedure that has to be taken irrespective of the industry.



Information on environmental aspects of products  
 Communication \ on environmental \ performance /  
 Description of environmental performance of organizations

Figure 5.1: ISO 14000 Model in an Integrated Plan-Do-Check-Act (PDCA) Cycle

Description of environmental performance of products

Improvement of environmental performance of products Information about the performance of the environmental management system

Figure 5.1 (adopted from <http://www.iso.org>) shows the ISO 14000 Model in an integrated Plan-Do-Check-Act (PDCA) cycle. The PDCA cycle was made popular by Edward Deming in quality management literature and has since been applied to several areas of study. Important information to derive from this is that the ISO 14000 model relies on effective planning, performance measurement, and monitoring. It is an ongoing process that seeks continuous improvement to achieve environmental quality. The

effective implementation of these guidelines is essential to achieving maximum benefits and this would require effective planning. You would also notice that environmental management systems auditing is now represented as ISO 19011. This new standard replaces the previous ISO 14010, 14011, and 14012 and deals with guidelines for quality and/or environmental management systems auditing and not just guidelines for environmental auditing as in the previous standards. Thus guidelines for quality and environmental management systems auditing are unified.

#### The Consumer and ISO 14000

The issue of standardization is of interest to consumers worldwide. Standardization ensures best practices and consistency in the delivery of products and services. It eases conformance to established guidelines and helps the regulation of products and processes. Consumers are protected from inefficient products and processes that are unsustainable. The quality of the environment and earth's limited resources are efficiently utilized.

Sustainability is not just of importance to consumers but to all stakeholders such as suppliers, manufacturers and vendors. We shall itemize some of the benefits of sustainable practices:

- Safer, healthier and environmentally friendly products are needed to improve the quality of life and productivity. Productivity as a measure of the economic wellbeing of a nation is enhanced when employees are safe and healthy. Environmentally sound products help to achieve the goal of increased productivity. One of the problems facing industrialized nations today is the increasing cost of healthcare and health insurance. Some of the health-related problems are induced by environmental pollution. Briggs estimates that 8-9% of total disease burden may be associated to environmental pollution and this figure is even higher for developing nations. Yet, this percentage of total disease burden may be underestimated because of long latency times, difficulty in linking a pollutant to a single disease and multiple exposures to different pollutants. Major sources of environmental pollution include unsafe water, poor sanitation, poor hygiene and indoor air pollution. Why some of these may require basic hygiene practices however, industrial pollution contributes significantly in creating unsafe

drinking water, poor sanitation, and poor air quality. For example, in many developing countries, there are few guidelines on factory locations and waste management. In such places, dumping of wastes and pollutants by manufacturers in streams and rivers and the lack of control on the emission of pollutants to the air pollute both the sources of drinking water and air. Standardization plays a role by specifying guidelines for best practices, sharing best practices worldwide, and educating regulators on standards to check for. The worldwide focus on best practices also compels manufacturers to carefully review and adopt ecologically friendly practices.

- In a global economy, it is important to have a level playing field. Consumers demand higher quality and quality extends to the role of the product on the environment. Consumers worldwide expect to get the same consistency of products and understand the need for safe and clean environment. They also participate in the green movement and would prefer manufacturers that are environmentally conscious. When a global company leaves its home base to compete in a new environment, it expects to meet exactly the same standards. By standardizing worldwide operations, the cost of operation and production is significantly reduced and high quality products that meet environmental needs can be delivered to customers at competitive prices. ISO standards facilitate international trade. By developing consistent standards, global companies can compete effectively by understanding the rules of the game. It would not matter if the company is based in Tokyo, Japan, or New Delhi, India, these companies do understand that there is a single world market that has to be catered for. Their products and services are evaluated using the same standards and their ability to compete effectively is dependent on their ability to satisfy these established standards and practices. So a sound business management practice would require knowledge of the guiding environmental management practices. The quest to meet and exceed these standards has made companies to become more innovative and find ways to turn environmental practices into profits. The cases of Kodak single use camera and Xerox remanufacturing practice show how corporations can be environmentally responsible and yet achieve high profitability.

- With the global economy, manufacturers are now dealing with global supply chain. Many manufacturers outsource part of their productions to other countries where cost of production is cheap, yet core competencies are available in such countries. Therefore, a manufacturer of aircrafts like Boeing may outsource the manufacture of wing flaps to Italy and expect to meet the same high quality and attain the same environmental standards. The attainment of these standards give consumers confidence that no laws are circumvented. In the past, multinational corporations relocated operations to countries where environmental laws were relaxed but today, they are joining in the effort to help such countries develop their environmental standards. Furthermore, with many of these countries as member nations of ISO, it becomes easier to develop consistent environmental standards worldwide. Using ISO 14000 standards and guidelines requires an evaluation of the value chain in order to support environmental protection and resource conservation efforts. This process helps in improving efficiencies and productivity. To effectively evaluate the value chain, the supply chain network becomes a critical component of this entire process. Many manufacturers have realigned their strategies with that of their supply chain to benefit from the global efficiencies these practices may lead to. So the issue is no longer being able to supply the cheapest cost but also being able to satisfy the standards and the reputation that the manufacturer wants. Thus the manufacturer and his team of suppliers work as team and share information on how to improve both product and environmental quality. Innovation is therefore critical in achieving both environmental performance and economic growth. Consumers in poorer countries stand to benefit from regulations since they could gain from the knowledge that exists in industrial nations. Poorer countries can benefit from this knowledge base without necessarily investing their resources on research and development to establish their own set of environmental laws. Green products create choices for consumers. Today's consumers are educated and have access to a wider range of information and database. They are able to make decisions that are rooted in their social and value systems. Consumers' perceptions of quality may be broader than the general definition of product quality and may focus on issues of social responsibility, integrity and trust [Madu and Kuei 1995]. Such focus on social

and value systems are often associated to green issues. Consumers tend to perceive conformance to environmental standards as an aspect of organizational social responsibility function. Consumers today have a wide range of products and services to choose from and environmental issues are increasingly factored in making such decisions. Adhering to internationally accepted standards as outlined in ISO guidelines attest to an organizational conformity to established standards and elevates the organization above its competitors that may not demonstrate this mark of achievement. Companies that embark on environmental quality improvement efforts meet the needs of their stakeholders. They appropriately respond to the environmental challenges and develop a reputation of being stakeholder-focused. This will help create a business image and reputation that may transcend into increased market share and thereby higher profit margins.

The use of ISO 14000 encourages environmentally sensible and conscious practices. This would also help to minimize ecological debts. According to Claude Martin, chairman World Wildlife Fund (WWF), "We are running up an ecological debt which we won't be able to pay off unless governments restore the balance between our consumption of natural resources and the Earth's ability to renew them," It is clear that a major problem is to be able to balance consumption of natural resources and the ability to renew the resources. While it is not always feasible to renew all resources, however, the use of ISO 14000 could help in responsible practices and in identifying sustainable practices that can extend the useful life of nonrenewable resources.

- In the past, different countries maintained different environmental standards. These standards were not universally accepted and were often contradictory. Such independent standards complicate international trade, regulation and monitoring, and do not protect global consumers. Today, the universal standards as achieved through ISO simplifies worldwide regulation, present the same view of environmental standards to all stakeholders, and assure consistency in achieving the standards. They facilitate international trade and ease entrance into new markets by foreign corporations. Consumers stand to benefit from competition, increased employment opportunities, and

the quest by competing companies to be the best and produce world-class products and services.

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