

# Types of Environmental Manufacturing

**M**ANUFACTURING COMPANIES are beginning to address how they negatively impact the environment. They are accomplishing this through a range of manufacturing methods, design processes, and concerns for the entire life of the product. Some companies are developing tools and software that allow them to do internal analyses of energy use and waste.



## Objective:



Identify types of environmental manufacturing.

## Key Terms:



environmentally benign manufacturing (EBM)  
environmental officers  
environmental protocols  
systems approach

## Types of Environmental Manufacturing

Environmental manufacturing can cover every aspect of manufacturing, from product design to final delivery. Companies addressing environmental manufacturing take different steps to create more environmentally friendly products and processes. These vary depending on the products being developed and the availability or possibility to utilize different techniques. Some steps are relatively simple, and others require long-term research and analyses.

## SUSTAINABLE AND LIFE CYCLE MANUFACTURING

Sustainable and life cycle manufacturing addresses the product and how it is manufactured. Its focus is on limiting the negative environmental impact that can exist over the full life cycle

of the product. It focuses on the need to develop innovative technologies for manufacturing that reverse global resource shortages and remove heavy environmental loads.

## Recycling

One type of sustainable manufacturing uses the concept of product take-back and recycling. It is an example of the **systems approach** (to manufacturing operations), which uses interconnected relationships between all aspects of product design, manufacturing, and distribution to coordinate recycling and the life cycle cost of products. Two aspects are reducing landfill contributions and reducing the need for new material resources. Concerned parties in this process include governments, manufacturers, consumers, communities, and recycling businesses.

The Hitachi Corporation is developing systems of design that allow for disassembly and recycling of their products. These systems will improve efficiency, reduce the company's carbon footprint, and develop reuse strategies in manufacturing. The development of information exchange loops are also being used to improve the management of a product's life cycle. These allow all the parties involved with a product, from its beginning to end, a way to communicate with each other.

## Product Life Cycle Analysis

Other companies are developing a systems approach that considers manufacturing in terms of their product's full life cycle. This includes specific design tools in which the product's end life is taken into account. These tools are used to create modular component designs, so their parts can be re-used easily. Reverse logistics models are used to analyze how products or manufacturing processes can become more sustainable. They are used to address the end-of-life issues for products. System analyses (or simulation models) are being used to study the overall product lifespan (long versus short) and the total costs involved.

## Limiting Carbon Footprints

Engineering laboratories are involved in defining processes for sustainability related to energy resource management, hazardous materials, and carbon footprints. This includes the development of computer software that can determine the carbon footprint of any product. The data can be used to determine the best material and manufacturing techniques to use. They can give numeric scores that allow manufacturers to see if a reusable or disposable material is more appropriate.



**FIGURE 1.** In our society, items are used for a brief period and are then sent to a landfill. Large amounts of resources, energy, and materials are wasted. New approaches to manufacturing are addressing issues such as sustainable and life cycle manufacturing.

## STANDARDS AND PERFORMANCE REGULATIONS

The development of standards and regulations for performance in environmental manufacturing is an ongoing local and international process. Many standards are currently under development by national and international organizations. The ISO is one organization addressing energy use, material resources, and pollution.

### Efficiency

Some standards establish methods of evaluation for environmental and energy efficiency in manufacturing, such as ISO 20140. These standards can be used to evaluate systems and to make improvements to the processes used on a machine line facility. They can help reconfigure the system for improvements to products.

The ISO 20140 has five parts that focus on different aspects of manufacturing and the environment. Part one consists of general principles and an overview. Part two includes guidelines for environmental evaluation procedures. Part three is an environmental evaluation index model. Part four is for an evaluation data model, and part five focuses on the facility life cycle impact and indirect impact through specific models or processes.

### Environmental Impact

Some standards (e.g., ISO 14955 series) evaluate the environmental impact caused by machine tools. Part one of this standard addresses eco-design methodology for machine tools. Part two gives methods of testing the energy consumption of machine tools and functional modules. Part three focuses on test pieces, test procedures, and parameters for energy consumption on metal cutting machine tools. Part four focuses on test pieces, test procedures, and parameters for energy consumption on metal forming machine tools. These standards will guide manufacturers in designing machine tools to meet efficiency goals. They also can be used to test and determine how well machines perform.

Regulatory mandates are being developed that control emissions standards for air, water, and solid waste; work exposure standards; product take-back requirements (or recycling); and the use of banned materials.



## FURTHER EXPLORATION...

### ONLINE CONNECTION: Landfills and Manufacturing Go Green

It can be complex for a company to organize a manufacturing plant so it is able to recycle all of its waste. But companies are beginning to do this. To learn more regarding how this is possible and to learn which companies are recycling and re-using, visit the following Web link:

[http://www.metacafe.com/watch/1254499/landfills\\_go\\_green\\_to\\_the\\_extreme/](http://www.metacafe.com/watch/1254499/landfills_go_green_to_the_extreme/)

## ALTERNATIVE PRODUCT AND PRODUCTION PLANS

Alternative product and production plans are an important part of environmental manufacturing. Some manufacturing techniques and products have the possibility to use a range of materials, designs, and systems.

In a systematic approach to manufacturing, one that addresses its environmental impact, research into material and process selection is part of the initial design process. In the case of existing products and facilities, it becomes necessary to modify manufacturing systems. The product and its production are re-evaluated in terms of their global impact, such as resource usage and waste streams.

### Processing Methods

Many companies are reconsidering options in their processing methods, including the sequencing or ordering of techniques for product assembly. They will improve the energy efficiency of the existing methods and assembly systems.

Some specific ways in which companies create environmental manufacturing solutions with production plans are by reducing waste, water consumption, and energy. The reduction of energy through lighting is achieved by using more efficient bulbs as well as better lighting plans and layouts. In this case, factory activity is studied in terms of human traffic and required lighting. Fixtures are placed only where and when they are needed. Energy meters are being installed to track and locate where and how much energy each element of operation requires.

Some companies have (and may be required in the future) to hire or give authority to **environmental officers**—employed authorities who give advice on and enforce environmental standards. Their concern is the end profit for the business and the negative environmental effects of the business.

## ENVIRONMENTALLY BENIGN MANUFACTURING

**Environmentally benign manufacturing (EBM)** is a process concerned with limiting the impact or negative effects of manufacturing on the environment. It can have a range of influence on products and procedures associated with manufacturing, all geared toward environmentally safe products and production.

A company developing shipping containers for benign frozen goods is studying Pykrete, which is a mix of wood pulp and water ice. The containers will reduce the amount of waste associated with packag-



**FIGURE 2.** The manufacturing of technology creates a lot of waste and can have negative effects on the environment, including leftover parts as seen here. Some companies are addressing this issue through environmentally benign manufacturing.

ing and bulk shipping for medicine and refrigerated foods. They can be used in the fishing industry, in the shipping of frozen foods, and in warehousing. The material can lower the entire life cycle cost, from the container's creation to its disposal.

### **Benign Products**

Some companies, including HP, are researching ways to create benign products in the manufacturing of technology (e.g., monitors, hard drives, printers, and circuit boards). IBM and Ford are developing new technology to create benign manufacturing procedures, including the Waste of Electrical and Electronic Equipment (WEEE) and the End of Life Vehicle (ELV). Ford is designing a car specifically for recycling, and IBM is designing a computer made from 100 percent recycled plastic housing.

### **Eco-Industrial Park**

The Department of Energy (DOE) is working with several manufacturers to create an eco-industrial park in Parkersburg, WV. It focuses on the recycling of electronics. Organizations are evaluating and researching companies that employ EBM to set up guidelines and communicate methods, including the the World Technologies Evaluation Center (WTEC). Examples include manufacturing that uses new processing methods to replace toxic lubricants; substitute energy usage with modification; and reduce solid, liquid, and atmospheric waste.

## **RESOURCE AND SUPPLY CHAIN**

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Refiguring the entire resource and supply chain can be one of the most difficult steps to adjust for environmental manufacturing. In some cases, there are only limited means to transport goods. This may be a result of the material used or the manufacturing location relative to the suppliers and distributors.

### **New Facilities**

New environmental manufacturing facilities are planned and designed to take advantage of the most efficient use of transportation. This includes locating the plant near resources and distributors to limit energy consumption.

### **Existing Companies**

Existing environmental manufacturing companies are changing their sources or requiring them to follow desired standards. These companies require their suppliers to comply with all local environmental regulations and to be active in environmentally responsible practices. This includes the use of alternative fuels for refining materials and in transportation methods.

They also try to ensure that manufacturing partners and suppliers follow all international **environmental protocols**, which are specific conventions or guidelines that are internationally agreed upon and recognized as standard procedures or practices.

## GENERAL ENVIRONMENTAL MANUFACTURING

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General types of environmental manufacturing can include internal changes and overall company practices. Many companies perform self-audits for energy use and waste. Some basic and simple rating systems can be used. Many are in the form of computer software or spreadsheets. Some are just for energy use where companies can input equipment and product ratings. The software supplies the company with energy use data. More complex software can be used to calculate a product's life cycle and supply chain cost. With this data, manufacturers can target areas for improvement.

Other general environmental manufacturing elements include changes to buildings to improve energy use by adding insulation and updating heating and cooling systems with more efficient ones. In some cases, new windows and doors are installed to save on heat loss or gain. Internal recycling is established for all products and materials. In addition, old lighting and water fixtures are replaced with more efficient fixtures. Machining and manufacturing equipment is updated or replaced to conserve energy and to minimize waste.

### Summary:

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Environmental manufacturing can include many steps. One type of sustainable manufacturing uses the concept of product take-back and recycling. For instance, the Hitachi Corporation is developing systems of design that allow for disassembly and recycling of its products. Standard and performance regulations include the ISO 20140 that focuses on different aspects of manufacturing and the environment. Other standards evaluate the impact on the environment caused by machine tools.

Some specific ways in which companies create environmental manufacturing solutions with production plans are reducing waste, water consumption, and energy. They may be required to employ environmental officers. Examples of EBM are a company developing shipping containers for frozen goods; IBM's recycled computer; and Ford's car design that allows for re-use.

Manufacturing facilities are planned and designed to take advantage of the most efficient use of transportation. Existing facilities are refiguring their supply and resource chains and requiring partners to meet environmental protocols. Other types of environmental manufacturing can include internal changes and overall company practices. Many companies perform self-audits for energy use and waste.

### Checking Your Knowledge:

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1. What type of manufacturing uses the concept of product take-back?
2. What is the systems approach that uses inter-connected relationships?

3. What international standard addresses eco-design methodology for machine tools?
4. What does EBM stand for?
5. List two general ways in which companies are becoming environmental manufacturers.

### Expanding Your Knowledge:

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There are various aspects of environmental manufacturing developing today. Many rely on recycling plants. To learn more about how recycling plants work, plan a visit to a local recycling plant. Create a list of questions beforehand so you are prepared to ask educated questions. Share your findings with your classmates.

### Web Links:

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#### **Eco-Responsibility**

[http://www.intel.com/en\\_XE/intel/responsibility/environment/index.htm](http://www.intel.com/en_XE/intel/responsibility/environment/index.htm)

#### **Apple and the Environment**

<http://www.apple.com/environment/>

#### **Answers for the Environment**

[http://www.usa.siemens.com/pool/about\\_us/cr/pdf/Siemens\\_eBrochure09.pdf](http://www.usa.siemens.com/pool/about_us/cr/pdf/Siemens_eBrochure09.pdf)