

LIFE CYCLE ASSESSMENT

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Each of us buys many consumer products during a week or a month. The environmental impact brought about by the development, manufacture, distribution, and disposal of these products varies greatly. Many claims are made by companies that a given product is more environmentally friendly than another one or a certain product is "greener" than another.

It is difficult to make purchase decisions based on stated environmental claims for a given product. One way to make an intelligent choice is to apply the "Life Cycle Assessment" technique. A life cycle assessment adds up all environmental impacts that result from making, using, and disposing of the products we buy. It studies all energy and raw materials used and the environmental consequences of each stage of development.

A complete life cycle assessment has three main components.

1. Life Cycle Inventory
 2. Life Cycle Impact Assessment
 3. Life Cycle Improvement Analysis
- A. A life cycle inventory measures the raw material and energy used to produce, use, and dispose of a given product.

The results of these processes will need to be measured to determine their environmental impacts.

1. Has the water been contaminated and is it now unfit for human or animal use?

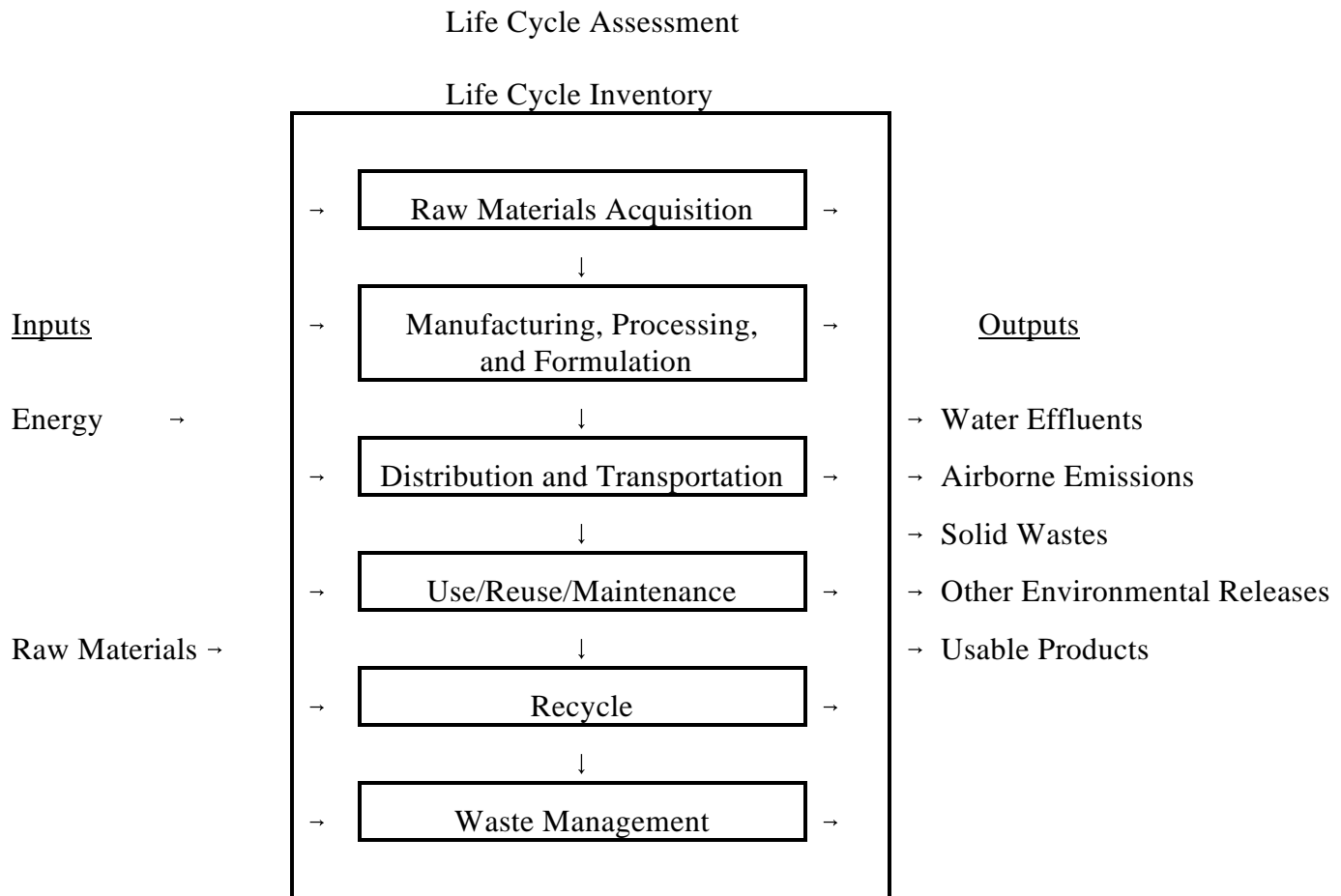
2. Have unsafe particulates been discharged into the air we breathe?
3. Is solid waste contaminating the environment? Are conditions unsafe for humans or animals?
4. Are other products released into the environment or usable products created? What effect do these have on human health?

There are five major processes included in the life cycle inventory.

1. The acquiring of appropriate raw materials
 2. The manufacturing, processing, and formulation of the products concerned
 3. The distribution and transportation of finished products
 4. The use, reuse, and maintenance of the product
 5. Management of the waste products generated by each of the above steps
- B. The next step involves studying the impact of the finished product on the environment. What effect do discharges into the water or air have on living things? Solid waste or other environmental releases also need to be studied.

C. The third phase of the life cycle assessment is the life cycle improvement analysis.

Careful study of the effects a finished product will have on the environment will enable the producer of the goods to take corrective action aimed at making the environmental impact more positive and more pleasant.



Another way to explain a life cycle assessment is that it is a detailed analysis that calculates the energy and raw materials used to produce a particular product or process and the resulting release of pollutants into the air, water, and land. The purpose is to allow valid comparisons between products and processes and enable users to make sound choices for the least environmental impact.

Automobile Life Cycle

To put this process into a familiar context, let us look at the life cycle inventory of the family car. Although the automobile is a major purchase the life cycle assessment principles apply as they do for purchases of lesser amounts made more frequently.

Appliances, furniture, household supplies, and equipment all lend themselves to this process.

The life cycle assessment process can be applied to any consumer product. Because the automobile exceeds most other household consumer durable items in terms of its required materials, energy demand, and contribution to the solid waste stream, and because most consumers can relate to the process of buying and using an automobile, the car is a good product to consider.

Following is a general description of the steps in the life cycle of a car. It does not include points B and C (analysis of environmental impact and improvement analysis) required for a complete life cycle assessment.

Stage One - Raw Materials

The first stage of the life cycle of a car is acquiring the raw materials. Mining of minerals, such as copper, iron, lead, zinc, and aluminum, results in environmental effects in the area near the mines, plus the effects of transporting them to the next stage.

Petroleum, required for energy use and as a raw material for certain parts of the auto, must be drilled and transported, with sometimes catastrophic injury to the environment. Other materials must be obtained for electronic parts, interior surfaces, paint and finishes, and all the other many parts of a car. Some of these raw materials are nonrenewable, with a finite supply that will be depleted someday.

Stage Two - Manufacture

The second stage of the life cycle of a car is the manufacturing, processing, and formulation of materials. Steel, plastic, glass, textiles, and rubber are all formulated from raw materials. Hazardous wastes are associated with the manufacturing process. Plastics, for example, generate large quantities of hazardous waste. Parts for the auto are manufactured in plants away from the assembly plant, so transportation is a major factor in this stage of the car's life cycle. As the parts are assembled into the finished product, various paints and coatings are applied, and lubricants and fluids are included. Each of these steps produces excess materials and uses energy, with a resulting environmental impact. Coal-burning power plants that provide energy for these processes, for example, are a major source of air pollution.

Stage Three - Distribution

Once the car is assembled it moves into the third stage. The vehicle is transported via truck, train, or ship to a car dealership. Whatever combination of transportation modes is used, the fuel and materials required to move the car from assembly plant to car dealer are polluting. Land is cleared to build the road system and car dealership. Each factory and assembly plant require land to be

cleared, resulting in the loss of habitat for wildlife and an increase in rainwater runoff.

Many consumers consider this point as the starting place for environmental impact of the car, but as we have seen it is by no means the beginning.

Stage Four - Use

The customer drives home in the new car and drives into the fourth stage of the car's life cycle. During a car's use and maintenance, it is driven, idled, air-conditioned, fueled, oiled, lubricated, washed, waxed, "antifreezed," and repaired. It may get new tires, seat covers, floor mats, upgraded stereo system, paint job, and/or window tinting. Each of these aspects of the car's useful life requires a business establishment, energy use, and resource use. Various amounts and levels of pollutants and solid waste are produced. The car itself pollutes.

When the owner decides he or she no longer wants or needs the car, usually he or she will buy a different car. The car may be sold to a new owner, or traded in toward a new one. At some point the owner will decide the car requires more time and money than it returns in utility. The car may be delivered to a junkyard, where components can be salvaged for use on similar cars still being driven.

Stage Five - Recycling

Now the car is ready for stage five, recycling. This stage may not occur for certain products, but in most cases cars are recycled. Three-fourths of the materials that make up a typical new American car by weight are, in theory, recyclable, though far less than that is actually reclaimed. Today, steel, iron, and aluminum rate highest in reuse. Plastics are increasingly used in cars, but pose problems for recycling because of the great variety of plastic formulations and the lack of an economically feasible processing program.

Recycling is not without its environmental impact. Recycling of steel and iron can result

in lead, cadmium, and chromium waste, which may be classified as hazardous. Air emissions are common when recycled steel and iron are remanufactured. Air emissions from aluminum recycling can contain particulate matter in the form of metallic chlorides and oxides, as well as acid gases and chlorine gas.

Stage Six - Waste Management

The final stage in an automobile's life cycle is waste management. Wastes are produced at each stage of the life cycle. These are recycled, released into the environment, or collected for processing in a compost, landfill, or waste-to-energy facility. Each of these options can be detrimental to the environment. For example, even when a landfill designed to minimize environmental damage is used, transporting the waste to the landfill produces pollution, and spills may occur enroute.

Conclusion

The above life cycle inventory, although general, provides an example of the potential impacts a particular consumer product has on the environment. It is missing several important elements, which are beyond the scope of this lesson. A complete life cycle assessment includes the quantities of each input and output throughout the process. It contains an analysis of the specific effects each of these steps could have on the environment. Given life cycle information, a person can judge which steps are the most damaging and how to make improvements to reduce those impacts.

Life cycle analysis can help to raise a consumer's awareness of a particular product's environmental impact. **Every product you can buy fits to some degree into this life cycle framework**, and has consequences on the environment, energy sources, and raw materials.

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