Retrace Your Waste: Life Cycle Analysis

CONTENT AREAS

- **Science** natural resources, energy use, air quality, water quality, solid waste, recycling
- **Geography** natural resources

OBJECTIVES

Students will…

- learn to use life cycle analysis to identify consumption of energy and materials and waste production in the life of a product as it moves through several stages from "cradle to grave"

MATERIALS

For the class

- Life Cycle Inventory
- Life of a Hamburger poster
- index cards
- varied assortment of consumer products and/or containers manufactured from a wide range of raw materials. Include items with which students are familiar.
- aluminum soda can
- newspaper or magazine
- clothing made from natural material
- small electronic device
- clothing made from synthetic material
- pencil or pen
- plastic or glass soda bottle
- school computer
- variety of food products with packaging
- handbag or backpack
- disposable diaper

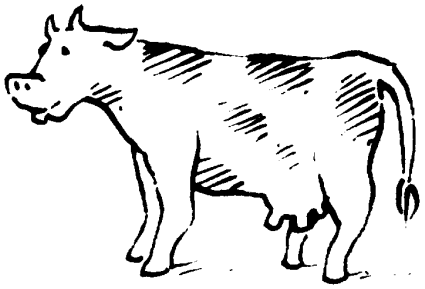
TIME

Two periods,
45 minutes each

Buying and using products that result in less garbage is one aspect of source reduction. Life cycle analysis gives a more complete picture of the waste and energy associated with a product. Rather than just looking at the amount of waste that ends up in a landfill or an incinerator, life cycle analysis is a cradle-to-grave approach: it measures energy use, material inputs and waste generated from the time raw materials are obtained to the final disposal of the product.

Although evaluating products over their entire life cycle can give a more complete picture, the process can be extremely complex. That's because products are evaluated through each of the six stages of the life cycle:

1. Acquisition of raw materials
2. Manufacturing and processing
3. Distribution and transportation
4. Use/reuse
5. Recycling
6. Disposal



Along the way, each stage receives inputs of materials and energy and creates outputs of waste emissions. Overall, these stages may have a significant environmental impact. This activity uses a game to introduce students to life cycle analysis. In the game, students use logical and critical thinking skills to trace a product through its life cycle in reverse order.

PROCEDURE

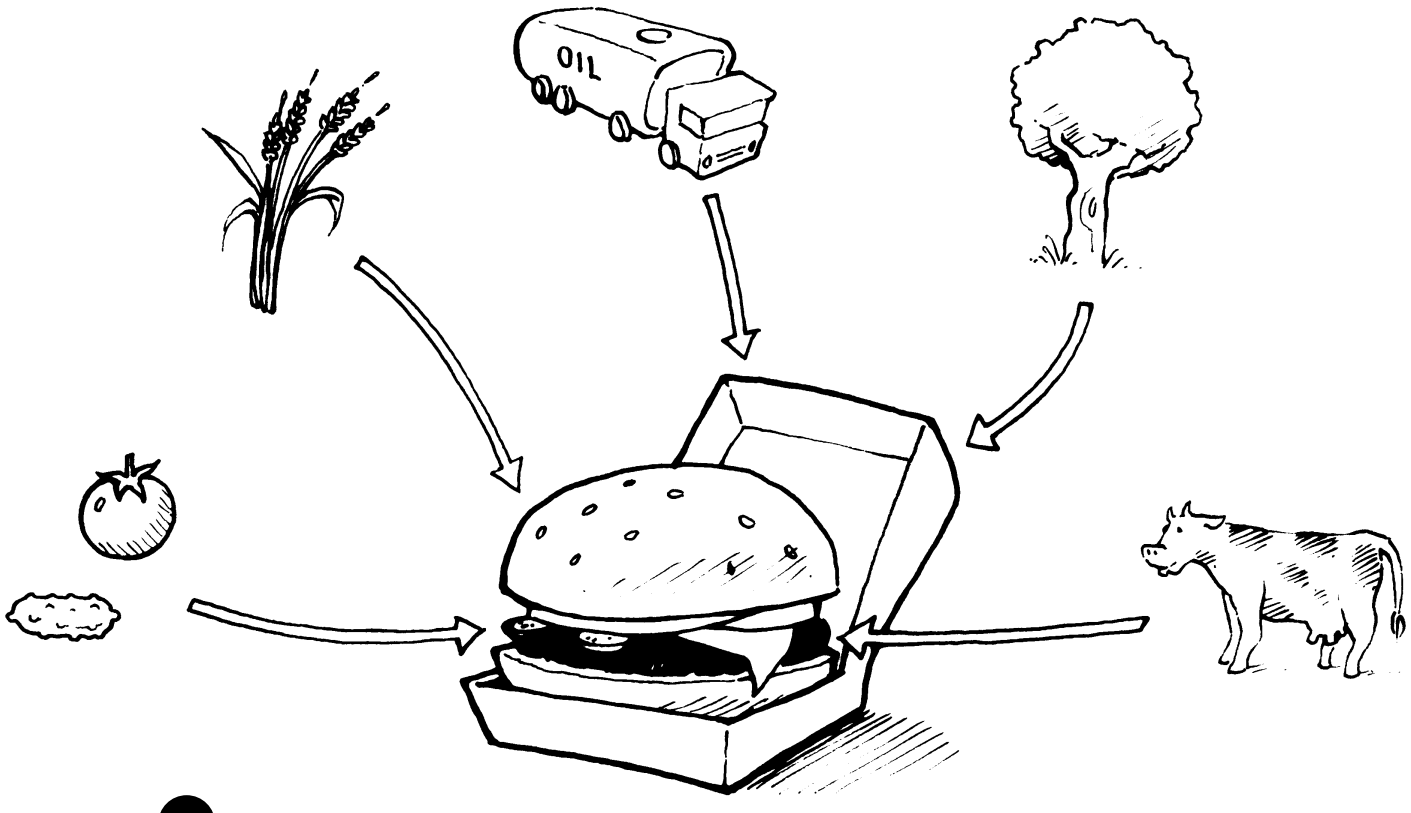
1. Introduce the concept of life cycle analysis. Use the chart as a handout or overhead. Lead students through the stages of the life cycle of a product, beginning with obtaining raw material and ending with disposing of the product. Along the way, give various examples of how energy is consumed and how waste products from air emissions, water effluents and solid waste are produced.

2. Inform students they will be retracing the life cycle of a product from its disposal to its raw materials source. Explain that life cycle analysis is actually very complicated, with several divergences along the path. It's all right if students do not see all the connections, but major ones should be grasped.

3. Instruct students to sit in a circle. Place the objects you have brought to class in the center, designated as the "waste stream," where the product is finally disposed of.

4. Explain the activity. One student will select an object from the waste stream. Beginning with the student who selected the object and moving clockwise around the circle, have students tell a life cycle story about the product, each student building on the previous student's statement. The first student starts with raw materials. The rest work through transportation, manufacturing and processing, packaging consumer purchase, use and disposal. (It may be helpful to write the steps on the chalkboard.)

5. As a warm up, the teacher should put up the poster and use a fast-food hamburger as an example. Hand students numbered index cards, which they can read from to trace the steps. For example, the teacher will start by saying "Let's take a look at all of the preparation that goes into serving a hamburger."



THE BURGER

1. Grain is grown, using a variety of fertilizers, herbicides, pesticides and significant amounts of water. Threshers, combines and tractors are used to sow, grow and reap the grain. All of this equipment burns fuel and emits pollutants and greenhouse gases.

2. The grain is shipped to cattle ranches or feedlots, where it is fed to cattle, along with water. Waste products include manure and methane.

3. Cattle are shipped by truck or train to market, where they are fed and sold. They are shipped again to processors.

4. At processing plants, the cattle are slaughtered and cut into large sections called primal cuts. These must be quickly refrigerated and aged. Waste products include unusable animal parts, waste water and manure.

5. The beef is shipped in refrigerated trucks and rail cars to food service warehouses, where it is ground, formed into patties and boxed and wrapped for use. It is stored and frozen until needed.

6. Beef patties are shipped via freezer trucks to stores and restaurants. They are kept in cold storage until needed, then cooked on a broiler or fryer. They are then put on a bun, topped with condiments, wrapped and put under hot lights until served.

7. Uneaten portions are thrown away.

Bun and condiments

8. Grain is grown for use in baking. Tomatoes, onions, pickles and lettuce are grown, using fertilizer, pesticides and herbicides, plus large quantities of water. Farm machinery is required. The machinery uses fuel, and some of the chemicals run off into water reserves.

9. Grain is shipped to mills, where mechanical equipment converts it into flour. The flour is packaged in bulk bags. Wastes include excess or unusable portions of the grain and excess packaging material. Vegetables are shipped to refrigerated warehouses, and held in storage until needed. Then, they are sent by refrigerated truck to stores and restaurants, where they are cut up, cooked and served.

10. Some tomatoes, cucumbers and onions are shipped to processing companies. Using mechanical equipment, tomatoes are processed into ketchup, cucumbers are pickled, and onions and pickles are used to make relish. Significant quantities of water are used in these processes. Ketchup production also requires high heat cooking. All food must be vacuum packed for freshness and sanitation.

11. The flour is shipped by truck or rail to bakeries, where it is mixed with water and other ingredients. The dough is then baked in ovens, which require significant heat energy in the form of gas, oil, electricity or wood. Once cooled, the buns are packaged and warehoused. Condiments also are packaged and shipped to warehouses. Then they are shipped to local stores. Waste includes leftovers, which are thrown away.

12. The buns are trucked to local stores, where they are used to make hamburgers. Waste includes leftover bread, which is thrown away.

Packaging

13. Trees are cut and oil or gas is drilled. The lumber and petroleum are shipped or piped to mills and refineries, respectively. Sand, soda and potash are mined and shipped to glass plants.

14. At the mill, lumber is pulped, using very large quantities of water and corrosive chemicals, including chlorine. Large machines then turn the pulp into paper, which is wound on rolls and stored.

At the refinery, petrochemicals are converted into ethylene, which is then polymerized to become polyethylene. Polyethylene is formed into pellets, packaged in bags and boxes and stored. Significant energy is required during these processes.

At the glass plant, the ingredients are mixed into the proper proportion and heated to very high temperatures, at which they melt to form glass. The molten glass is poured into molds and cooled to make bottles.

15. The paper and plastic are shipped via truck or rail to manufacturing plants, which make a variety of products: poly-coated paper for use in wraps and boxes ("clam shells"), paper for use in bags, plastic wrap for use in bread, meat and vegetable packaging and cardboard for use in pallets and boxes.

Glass bottles are shipped to the ketchup and relish plants, which use them for packing.

16. Finished packaging is shipped to points where it is needed. Wastes include most, if not all of the used packaging, including the clam shell and/or wrap used to provide you with a fresh-cooked, sanitary hamburger.

QUESTIONS

Have students discuss and summarize the life cycle analysis. Questions might include:

a. What inputs and outputs resulted from manufacturing this product?

b. Are all the outputs equal in terms of environmental effects?

c. What were the environmental effects, and could any be minimized?

d. What other resources were consumed as a result of this product's manufacture and distribution?

e. Do you see how using less has a huge impact throughout a product's life?

At the end, ask students:

a. Will you look at products differently now?

b. What considerations do you now have as consumers that you did not have before?

c. Do you see how using less has a huge impact throughout a product's life?

d. Where does the real waste occur in the production of hamburgers?

EXTENSIONS

1. Have students work in small groups to research a business to learn its operating philosophy, manufacturing approach, environmental position, research and development activities, and special problems relating to its industry, including waste management.

2. Ask students to select a favorite item and research and then write or illustrate a life cycle analysis about it. If possible, have them contact manufacturers for information.

3. Draw your own life cycle posters.

4. Determine where and what types of waste are generated.

Life Cycle Inventory