Technology and the Environment

Foundations of Technology,
Montgomery County Public Schools

Outcomes

In this presentation you will learn:

- Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. (ITEA 5-G)
- When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. (ITEA 5-H)
- With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. (ITEA 5-I)
- The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. (ITEA 5-J)
- Humans devise technologies to reduce the negative consequences of other technologies. (ITEA 5-K)
- Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. (ITEA 5-L)

Balance Between Technology and Environment

There is a delicate balance among people, technology, and the environment. For example, conservation of natural resources, improvement of older technologies, and large-scale use of technologies are resulting in global changes.

Learning to appreciate the decisions that are made to maintain a balance among society, technological use, and the environment is central to developing technological literacy.

Although many technological products or systems are developed with the good of the environment in mind, sometimes unintended side effects occur. For example, the automobile is a great form of transportation but the exhaust emissions have created air pollution.

Air Pollution

Humans probably first experienced harm from air pollution when they built fires in poorly ventilated caves. Since then we have gone on to pollute more of the earth's surface. Until recently, environmental pollution problems have been local and minor because of the Earth's own ability to absorb and purify minor quantities of pollutants.

The industrialization of society, the introduction of motorized vehicles, and the explosion of the population, are factors contributing toward the growing air and water pollution problem. At this time it is urgent that we find methods to clean up the air and water.

The primary air pollutants found in most urban areas are carbon monoxide, nitrogen oxides, sulfur oxides, hydrocarbons, and particulate matter (both solid and liquid). These pollutants are dispersed throughout the world's atmosphere in concentrations high enough to gradually cause serious health problems.

You cannot escape air pollution, not even in your own home. "In 1985 the Environmental Protection Agency (EPA) reported that toxic chemicals found in the air of almost every American home are three times more likely to cause some type of cancer than outdoor air pollutants".

Water Pollution

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. When it is unfit for its intended use, water is considered polluted.

Comprising over 70% of the Earth's surface, water is undoubtedly the most precious natural resource that exists on our planet. Without the seemingly invaluable compound comprised of hydrogen and oxygen, life on Earth would be non-existent. Water is essential for everything on our planet to grow and prosper.

Although we as humans recognize this fact, we disregard it by polluting our rivers, lakes, and oceans. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate.

In addition to innocent organisms dying off, our drinking water has become greatly affected as is our ability to use water for recreational purposes. In order to combat water pollution, we must understand the problems and become part of the solution.

To support a country's population and economic goals, there needs to be a steady supply of high quality fresh water. Desalination and water purification is just one of the many technologies being explored to harness the water for potable use...that is, water that is safe to drink.

Desalination refers to any of several processes that remove the excess salt and other minerals from water in order to obtain fresh water suitable for animal consumption or irrigation, and if almost all of the salt is removed for human consumption, sometimes the process produces table salt as a by-product.

Technological Trade-offs: Types of Pollution

There are several main *types* of pollution and well-known *effects* of pollution which are commonly discussed. These include smog, acid rain, the greenhouse effect, and "holes" in the ozone layer. Each of these problems has serious implications for our health and well-being as well as for the whole environment.

Particulate Matter: One type of air pollution is the release of **particles** into the fuel for energy. Diesel smoke is a good example of this *particulate matter* . T are very small pieces of matter measuring about 2.5 microns or about .000 type of pollution is sometimes referred to as “black-carbon” pollution.

The exhaust from burning fuels in automobiles, homes, and industries is a r pollution in the air. Some authorities believe that even the burning of wood a fireplaces and barbeques can release significant quantities of soot into the air.

Smog: A type of large-scale outdoor pollution. It is caused by chemical reactions between pollutants derived from different sources, primarily automobile exhaust and industrial emissions. Cities are often centers of these types of activities, and many suffer from the effects of smog, especially during the warm months of the year.

Acid Rain: Another consequence of outdoor air pollution is **acid rain**. When a pollutant, such as sulfuric acid combines with droplets of water in the air, the water (or snow) can become *acidified* . The effects of acid rain on the environment can be very serious. Acid rain damages plants by destroying their leaves, it poisons the soil, and it changes the chemistry of lakes and streams. Damage due to acid rain kills trees and harms animals, fish, and other wildlife.

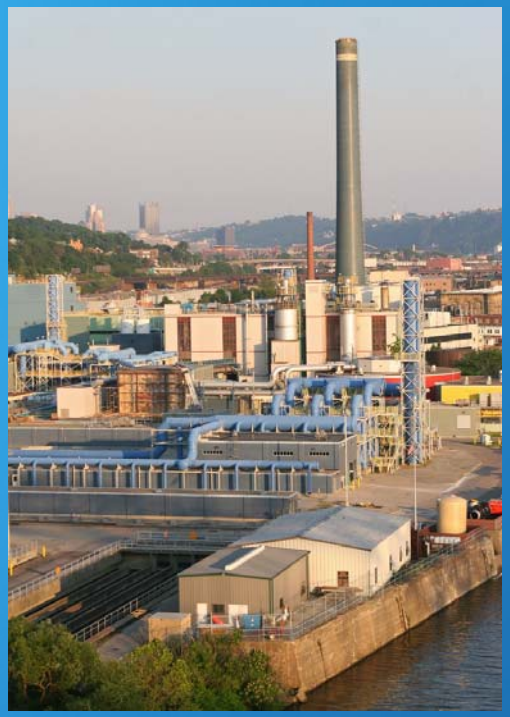
Technologies Help Reduce Negative Impacts

Thanks to the automotive industry's research efforts and new technologies for cleaner burning fuel engines, pollutant gas emissions from vehicles are halved every five years. By fitting its gasoline cars with catalytic converters, some automakers achieves close to a 99% reduction in the concentration of carbon monoxide (CO) and nitrogen oxides (NOx) in exhaust fumes.

Other technologies help to remove some of the carbon dioxide from coal-fired power plants. Technologies are used to filter and clean the water.

Monitoring the Environment

With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. Water treatment and filtering technologies can facilitate the reuse of water; wind and water erosion can be reduced by no-till farming; and aluminum containers can be recycled.



Sewage treatment plant

How You Can Reduce Pollution

You can help to reduce global air pollution and climate change by driving a hybrid energy efficient car, walking, bicycling, and using mass transit when possible. The simplest technologies can help solve the most complex problems.

Replace incandescent light bulbs with compact fluorescent bulbs, make your home more energy efficient using the latest technologies buying only energy efficient appliances.

Recycle newspapers, aluminum, and other materials. Plant trees and avoid purchasing products such as Styrofoam that contain CFCs. Support much stricter clean air laws and enforcement of international treaties to reduce ozone depletion and slow global warming. Earth is everybody's home and nobody likes living in a dirty home.

Technological and Natural Processes

The world is full of systems and cycles that keep the planet working. These systems and cycles can be a technological process or a natural process. Technological processes are the activity side of technology - the make and do component. It is the most important part. A natural process is a process existing in or produced by nature rather than by the intent of human beings.

Technological processes give humans the capability to engage in technological activity to be able to develop technological solutions to problems. The result of technological activity is products and services that people need or want, either for personal consumption or for company or industrial use.

Renewable and Exhaustible Materials

Few materials occur in nature in usable form. Most must be changed into new forms before they can be used as inputs in the manufacturing process. All materials may be grouped into two categories — **Renewable** and **Exhaustible** materials.

Renewable resources are living things. They sprout from seeds or shoots, or they are born — like the ant.

Exhaustible resources are in limited supply in nature. When they are used up they will be gone and can never be replaced — like coal.

Over time, renewable resources grow and mature and then they die. These materials may go through their life cycles without human care. They may grow in a forest, on a mountainside, or on a plain. Renewable resources are part of nature

People, however, grow many of these materials. Humans engaged in farming (growing food and fibers) and forestry (growing trees) may produce these materials. Commonly used renewable material resources are trees, grains, animals, fish, fruits, and vegetables.

Exhaustible Materials

Many resources are exhaustible. There are only so many of these resources on Earth. When exhaustible resources are used, they will be gone and can never be replaced. This type of resource provides a unique challenge. People must use each resource very wisely. Wasted resources are gone forever. Changes in habits and attitudes will not bring them back. New resources cannot be grown.

Common exhaustible resources include petroleum, natural gas, coal, mineral ores (such as iron, copper, and aluminum) farm soil, clay, and chemical deposits (such as salt and sulfur). These resources are obtained by mining and drilling.

Technological Processing of Natural Materials

Most raw materials have little value to people in their own rights. We cannot use them as they come from the ground. These materials must be processed into something more useful and this is where the alignment of technology and nature takes place. Often resources found in nature are mixed with other materials. In this condition, it has limited value. Iron ore is of little use to us in its natural state. Likewise, a pile of harvested trees (logs) cannot be used easily.

Processing natural materials (made by nature) using technological processes (devised by man) falls into three general categories:

1. Mechanical processing
2. Thermal processing
3. Chemical processing

Mechanical Processing

Mechanical Processing uses machines to cut, slice, crush, or grind material into new forms. The size and shape of the natural resources are changed. Grain is ground into flour. Rocks are crushed into gravel. Trees are cut into lumber, veneer, and chips.

Harvested logs from trees

to

Lumber to build homes

Thermal Processing

Thermal Processing relies on heat to process materials. The materials are melted or softened so they can be changed into more useful materials. Iron ore, coke, and limestone are heated together in a blast furnace. This action produces pig iron. Later, the material is thermal processed into steel.

Blast Furnace

Molten Steel

Chemical Processing

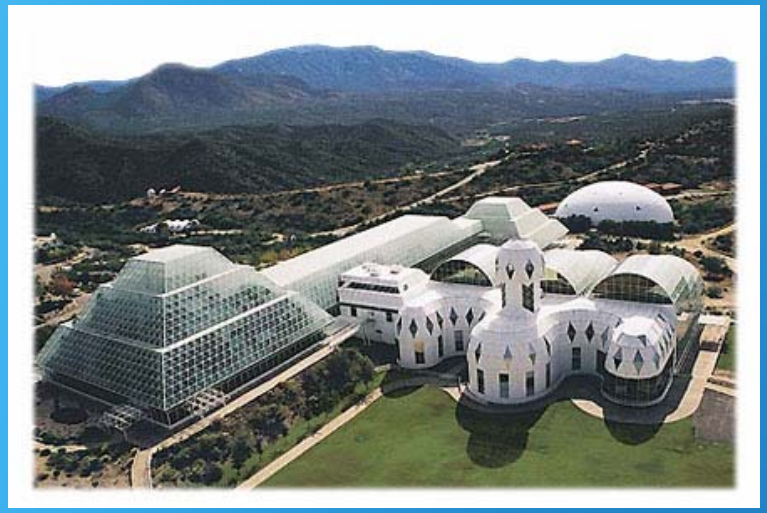
Chemical Processes are altered using chemical actions. Gold is removed from its ore using an arsenic chemical process. Natural gas changes into plastic when chemicals react with it. Aluminum is produced using a combination of electricity and chemicals. This is called an electrochemical process.

gold bars

aluminum can

Aligning Technological and Natural Processes

Biosphere 2 is a manmade closed ecological system in Oracle, Arizona. Constructed between 1987 and 1989, it was used to test if and how people could live and work in a closed biosphere. It explored the possible use of closed biospheres in space colonization (Biosphere 1 is planet Earth).



Biosphere 2

The experiment showed the difficulty of copying the functions of the natural capital of the Earth biosphere with infrastructural capital constructed by humans. Despite expenditure of over $150 million, this attempt at a new biosphere did not sustain eight humans for a prolonged time. Biosphere 2 is currently exploited as a tourist attraction.

Alignment of Technological and Natural Processes

By way of example, consider all the products and services that are consumed/used every day by you and everyone else (food, clothes, cars, bikes, skates, banking, takeout food, ...).

Technological capability means being able to produce those products and services. We use what we get from natural processes and technological processes to help us make products to meet our wants and needs.

The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.

The slides that follow show examples of the alignment of technological and natural processes.

Hydroponics

– Growing Plants Without Soil

Derived from the Greek “water working”, hydroponics simply means growing plants in either a bath or flow of highly oxygenated, nutrient rich water. The strange part is hydroponics does not need soil to grow. During hydroponics water is enriched with nutrients salts, creating a hydroponics nutrient solution that remains perfectly balanced. The advantage of hydroponics is it does not harm the environment as does waste from fertilized soils.

Hydroponics may also be called “controlled environmental agriculture” as it helps to control the environmental systems like water, light, CO_2, oxygen, pH and nutrients.

Plants need soil to grow, right? Not really. Jumbo squash is grown in this greenhouse using hydroponics.

Biodegradation

Biodegradation is nature's way of recycling wastes, or breaking down organic matter into nutrients that can be used by other organisms. "Degradation" means decay, and the "bio-" prefix means that the decay is carried out by a huge assortment of bacteria, fungi, insects, worms, and other organisms that eat dead material and recycle it into new forms.

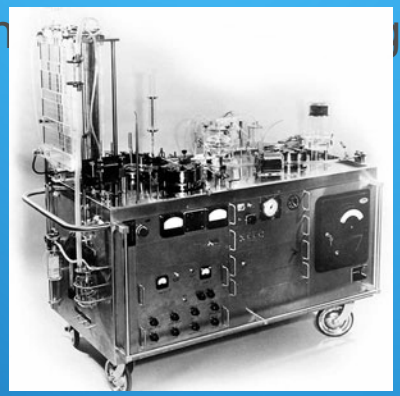
In nature, there is no waste because everything gets recycled. The waste products from one organism become the food for others, providing nutrients and energy while breaking down the waste organic matter. Some organic materials will break down much faster than others, but all will eventually decay.

By harnessing these natural forces of biodegradation, people can reduce wastes and clean up some types of environmental contaminants — composting is an example.

Heart-Lung Machine

During an open-heart surgery (such as valve or bypass surgery), the heart-lung machine is used to take over the functions of the heart and lungs. Also known as a cardiopulmonary bypass machine, it allows the surgeon to carefully stop the heart while the vital organs continue to receive blood and oxygen. When patients are on the heart-lung machine, very delicate work can be performed by surgeons without interference from bleeding or the heart's pumping motion.

When first used successfully in humans in 1955, the machine was a revolutionary piece of equipment. Today, the heart-lung machine is used in about 1 million cardiac surgeries every year, including surgeries to the coronary arteries, heart valves and other structures of the heart. The heart-lung machine has a very low complication [illegible] 1 [illegible] surgeries.



Gibbon heart-lung bypass machine 1955

Terumo Cardiovascular Systems Corporation (Terumo CVS) heart lung machine. 2003

Ozone: Unintended Consequences

Ozone is a gas that occurs both in the Earth's upper atmosphere and at ground level.
The layer closest to the Earth's surface is the troposphere. Here, ground-level or "bad" ozone is an air pollutant that is harmful to breathe and it damages crops, trees and other vegetation. It is a main ingredient of urban smog. The troposphere generally extends to a level about 6 miles up, where it meets the second layer, the stratosphere. The stratosphere or "good" ozone layer extends upward from about 6 to 30 miles and protects life on Earth from the sun's harmful ultraviolet (UV) rays.

Ozone is produced naturally in the stratosphere. But this "good" ozone is gradually being destroyed by man-made chemicals referred to as ozone-depleting substances (ODS), including chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons, methyl bromide, carbon tetrachloride, and methyl chloroform. These substances were formerly used and sometimes still are used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants.

Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.

Ozone Depletion

Once released into the air these ozone-depleting substances degrade very slowly. In fact, they can remain intact for years as they move through the troposphere until they reach the stratosphere. There they are broken down by the intensity of the sun's UV rays and release chlorine and bromine molecules, which destroy the "good" ozone. Scientists estimate that one chlorine atom can destroy 100,000 "good" ozone molecules.

Ozone depletion can cause increased amounts of UV radiation to reach the Earth which can lead to more cases of skin cancer, cataracts, and impaired immune systems. Overexposure to UV is believed to be contributing to the increase in melanoma, the most fatal of all skin cancers. Since 1990, the risk of developing melanoma has more than doubled.
UV can also damage sensitive crops, such as soybeans, and reduce crop yields. Some scientists suggest that marine phytoplankton, which are the base of the ocean food chain, are already under stress from UV radiation. This stress could have adverse consequences for human food supplies from the oceans.
The EPA has established regulations to phase out ozone-depleting chemicals in the United States. Warning labels must be placed on all products containing CFCs or similar substances and nonessential uses of ozone-depleting products are prohibited. Releases into the air of refrigerants used in car and home air conditioning units and appliances are also prohibited.

Some substitutes to ozone-depleting products have been produced and others are being developed. If the United States and other countries stop producing ozone-depleting substances, natural ozone production should return the ozone layer to normal levels by about 2050.

Summary

- Water is a precious resource, and a resource we depend on for our life. Only 1% of the world's water supply is drinkable.
- The world is full of systems and cycles that keep the planet working
- Humans use technological processes and natural processes with positive and negative effects
- There are hundreds of materials available. They can be used in various ways to meet human needs and wants.
- All materials are renewable or exhaustible.
- Renewable materials can be grown and harvested
- Proper management will give us a constant supply of resources
- Exhaustible resources have a limited supply and cannot be replaced once they are used up
- Exhaustible resources require careful use if future generations are to have them, too
- All materials must be grown or located in nature. They must be harvested or extracted.
- Materials must be changed to meet our needs and wants using state-of-the-art technological processes
- Materials are a basic input to technological processes as systems
- Technological processes as well as natural processes are used in agriculture, energy conversion, information processing and communication, construction, manufacturing, medical, and transportation technologies