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ABSTRACT

In the early 1990s, efforts were initiated to help countries move toward a solution of the global pollution problem. Technology education classrooms and laboratories are among the best places for bring the concepts of recycling/reuse and waste management to students' attention. Important concepts about pollution, waste prevention, and recycling can be taught as stand-alone units or dovetailed into units on construction, manufacturing, energy, and transportation. Technology teachers can obtain a wealth of information about recycling, waste management, and environmental education from the U.S. Environmental Protection Agency, the International Technology Education Association; and the Internet. (Contains 32 references and a list of 11 Internet sites providing activities focusing on recycling/reuse and energy savings.) (MN)

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RECYCLE/REUSE: UTILIZING NEW TECHNOLOGY

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RECYCLE/REUSE: UTILIZING NEW TECHNOLOGY

The 20th century is quickly slipping away and historians are recording the progress that society has made, and the problems that remain. As a global society, we have moved forward in many areas, but have stumbled in others. Aided by technological developments, great strides have been made in transportation, communications, and production systems. We have also been encouraged by successes in agriculture and medical research. However, as future generations review our accomplishments, it will be noted that we still had many hills to climb.

One of these hills was in the area of our relationship with the environment. As the Industrial Revolution blossomed, humankind seemed to forget about the ecosystems of the planet. For the past 200 years, we have been pillaging our natural resources and polluting the air, water, and earth. Some historians have labeled us the throwaway society because of the millions of cubic feet of trash that enters landfills daily.

Six years ago, in a meeting of the Rio Earth Summit, an attempt was initiated to help countries move toward a solution to global pollution. One of the areas outlined as major step toward a solution was recycling. Although recycling was not a new idea, it was the first time that an influential world organization had placed global emphasis on that area. Representatives to that meeting returned to their countries with the recycle focus as a primary objective. For both rich and poor nations, the Rio Earth Summit provided a cohesive global perspective as to the steps needed to reduce environmental damage and stretch the longevity of our natural resources.

Recycling Mentality

Recycling is probably as old as humankind. Primitive people valued what natural resources were available and did not waste them. One of the first places in written word where we read a version of recycling was in the Bible. Isaiah stated, ". . . and they shall beat their swords into ploughshares, and their spears into pruning hooks . . ." (Isaiah Chapter 2, Verse 4). More than 2,000 years ago, humans realized it was far simpler to reforge or remelt metals than to make new ones using primary ores. Recycling saved human energy beginning with the mining of the raw materials through the processing to final product.

The key to a successful recycling program is to get everyone involved. Channeling waste back into useful products needs to be a priority of local, state, and national governments. In the late 1970s, the idea of "closing the loop" became popular and was encouraged. New technology that entered the world market enabled nations the opportunity to slow down the volume of solid waste being deposited in landfills. However, it was not until a decade later when the new technology was well established, that the "closing the loop" became economically viable. An example is the country of Germany. During the 1980s Germany was being buried in waste. The high cost of the technology to recycle materials made it much more economical for cities and towns to truck the waste to landfills. By the early 1990s however, the investment needed for new technology had come down and with the passage of the German Packaging Ordinance the number of trucks going to landfills declined. Between 1991 and 1995 the consumption of sales packaging dropped by 900,000 tons and almost 20 million tons of bags, boxes, cans and bottles were recycled ("Philosophy," 1997). New innovations in sorting, preparation and recycling

technology have made the process more economical and moved the country a little closer to the solution of its solid waste problem.

Reasons for Recycling and Reusing

Solid waste. We are being buried in our solid waste. The average American family produces approximately 100 pounds of trash each week. If all of this were going to the local landfills the amount would be 5, 200 pounds per year. At that rate, we would need 500 new landfills every year (BellSouth, 1996).

A major culprit in contributing to this problem is excessive packaging of consumer products. Over packaging products not only stresses landfills, but also puts a strain on natural resources. Additionally, often times the package costs as much as the product. To form a clearer picture of the magnitude of this problem, the following information from the Canadian province of Ontario is presented.

- Ontario produces almost 40% of Canada's municipal solid waste which equals about one metric ton per person per year.
- In 1987, packaging represented 21% of that solid waste by weight.
- Approximately 75% of that solid waste was recyclable from a technological perspective, but only 18% was recycled (Canadian Council, 1992).

It is only logical that if less material is used to package and market a product, there will be less waste going to the landfill. It would also mean that consumers would pay less for the packaged product plus save on landfill costs.

Depletion of energy resources. It takes less energy (coal, gas, petroleum) to make recycled products than it does to make the same products from virgin materials. The process of producing aluminum from bauxite ore requires a great amount of energy. If aluminum is recycled, there is a savings of 95% of the energy needed to mine, ship and convert the raw material (Reynolds Aluminum, 1995). The administrators of San Francisco's recycling program also did some calculations on energy saving. They estimated that for every ton of aluminum that residents recycled, there was a savings of 14, 250 kilowatts of electricity, or enough energy to power the average home for a 20 month period (San Francisco, 1997).

Water pollution. Pollutants pumped into the air, dumped into streams, and thrown on the soil eventually find their way into drinking water. Harmful effluents come from factories, refineries, waste treatment plants and our homes. Contaminants also enter our water supplies from the atmosphere in the form of acid rain and from soil/groundwater systems which can contain residues from human agriculture practices. All these pollution sources contribute to unsafe drinking water, unbalanced or dead ecosystems in streams, rivers and lakes, and deforestation.

Science and technology provide many tools to help prevent pollutants from entering our ecosystems and ways to deal with them when they are already present. These tools however, come with a price that is both monetary and societal. Pollution prevention and removal equipment is costly, but not as much as the human suffering that takes place. Individuals can

choose their courses of actions and the impact they will have on our planet. We determine how products are packaged, what type of vehicle to drive, and what and how much to recycle. All these decisions contribute to the amount of emissions that end up in the life blood of our planet, "water."

Air pollution. Medical specialists attribute many early deaths that people suffer to the air that they breathe. It is estimated that each year there are 64,000 people who may die prematurely from cardiopulmonary causes linked to air pollution (National Resource Defense Council, 1996). A significant number of these yearly deaths could be averted if there were stronger health standards that were closely policed. The cities in the United States with the worst air pollution are as follows: Los Angeles, New York, Chicago, Philadelphia and Detroit. People who live in these metropolitan areas can have their lives shortened by an average of one to two years (NRDC, 1996).

Air pollution consists of smoke, soot, inorganic particulates, gaseous emissions and volatile organic compounds. Primary sources of these pollutants are coal-fired power plants (older), industrial boilers, manufacturers, and petroleum powered vehicles. Toxic emissions from these sources cause acid rain which damages animals, plants, soil, water, building materials and people.

New inventions and technology are designed to make every-day-living a little more pleasant. Each technological breakthrough moves society forward, but we also need to be prepared to deal with its negative impacts. Everyday practices can help reduce air pollution. Use energy efficient light bulbs and appliances, properly maintain transportation vehicles and recycle as much as possible.

Destroying plant and animal species. Loss of environment is detrimental to plant and animal species. This was verified during the last fifty years with the loss of forests on a global scale. Many of the significant discoveries of the 20th century, particularly in the field of medicine, came from the study of living things. Rainforests, which are being cut at an alarming rate, house many undiscovered species of animals and plants. How many of these species will succumb to the chainsaw and bulldozer? How many wonder drugs might have been if it were not for the want of virgin lumber?

The loss of rainforest is not limited to other parts of the world, but takes place even in our back yard. Newsom (1996) brought this to our attention when he wrote about the rainforest on the coast of North America. He related the plight of the temperate rainforest of British Columbia which was being clearcut to feed California's appetite for wood and paper. An example cited was a telephone company that was consuming great amounts of virgin wood fiber for its directories, one-third of it coming from the British Columbia rainforest. Unfortunately, millions of these phone books were being disposed of each year in landfills, and not recycled. When wood fibers are recycled, it saves energy, cuts down air and water pollution, and saves species habitats. One ton of recycled paper saves 17 trees (Draw Enterprises, 1998).

Contemporary Recycling Technology

Many of the everyday items bought in stores are designed for a certain period of usefulness and then discarded. The problem with these items is out-of-sight does not necessarily mean they are not still there. Contemporary technology has provided facilities and processes to recycle and/or reuse most of these items. From automobiles to yard scraps, there is an environmental friendly alternative to the throwaway syndrome.

The following paragraphs provide information and data about the progress being made in the effort to deal with the solid waste problem. At the conclusion of 1996, every state except Alaska, Arizona, Kansas, Oklahoma, Utah and Wisconsin had set a recycling and/or wast reduction goal (Goldstein and Glenn, 1997). Materials and items that are recycled have been placed in categories familiar to the general public.

Aluminum

When we think of aluminum and recycling, the first thing that comes to mind is beverage cans. According to the Environmental Management Division of Urbana, Illinois (1995); the average American uses 364 aluminum cans and 2.4 pounds of aluminum foil per year. Additionally, it was noted that each year, the United States discards enough aluminum to completely rebuild the American commercial airline fleet. That appears to be a lot of metal, but it is only a small percentage of the aluminum waste stream.

Worldwide, aluminum has a high recycling rate. In 1993, Americans recycled 59.5 billion aluminum cans, which was three billion more than in 1991. This raised the national aluminum can recycling rate to two out of every three cans. Energy savings alone from the 1993 effort was enough to light a city the size of Pittsburgh, Pennsylvania for six years (Can Manufacturing Institute, 1997).

Recycling aluminum cans has also placed money in the pockets of Americans. Since the early 1970s, they have earned $8.9 billion for their efforts. The Can Manufacturers Institute (1997) also stated that aluminum cans are recycled and returned to store shelves as new cans in as little as 60 days. This means that the consumer could purchase basically the same recycled aluminum can from the store about every 2 months or 6 times per year.

Aluminum cans are not the only source for recycling the metal. Aluminum foil along with parts from appliances are other sources. Automobiles also contain many parts made of aluminum. Sport wheels for automobiles and small trucks have been popular for many years. These wheels are usually aluminum and are recycled. However, in the process to manufacture them, much waste occurs. Approximately 30% of each casting is machined away as chips. These chips are collected, remelted and then used to make additional wheel castings. Very little is wasted in the manufacturing process, even the cutting oil is continuously recycled.

The automobile industry relies on recycled aluminum for many vehicle parts. Common items are frames, bumpers, and engine parts. The manufacturer of the Jaguar has produced a V-12 engine cylinder block that is made of recycled aluminum. Chrysler Corporation uses aluminum for the 1998 Concorde hood and inner and outer parts. The Plymouth Prowler has an aluminum body and frame. The amount of aluminum in an average passenger car has increased

from 191 pounds in 1991 to a present level of 262 pounds. Approximately 60% of the aluminum in a new car is recycled metal (Alcoa, 1997).

Batteries

Batteries are electromagnetic energy storage units that are used to supply power for a multitude of items and machines. They are found in cameras, radios, watches, flashlights, toys, cordless tools and appliances. Batteries are also the main source of power for ignition and lighting for automobiles, trucks, boats, golf carts, forklifts and wheelchairs. Batteries of many of these items become useless, after their energy is consumed, and this results in a major waste disposal problem.

Eventually, both wet cell and dry cell batteries must be replaced. Canada has gathered some interesting statistics concerning these throwaway energy sources. The Recycling Council of Ontario (1992) estimated that Canadians discarded 7,119,882 lead-acid batteries in 1991. Ninety percent of that total were recycled. All parts of the wet cell are consumed for new products. The plastic from the battery casing is chipped and formed into new casings. The lead plates are smelted into lead ingots which are then made into new battery plates. Bullets and automobile wheel weights are also made from the recycled plates. Finally, the sulphuric acid is collected, filtered and reused.

When lead-acid batteries are discarded improperly, harmful substances are released into the environment. Lead has been found to adversely affect the mental behavior patterns of children and brain damage and cancer result from prolonged exposure. Sulphuric acid can contaminate soil and air which eventually finds its way back into our drinking water.

Dry cells, which are commonly called household batteries, come in different types. Common classifications are mercury oxide, alkaline, zinc carbon/zinc chloride and nickel-cadmium. Several processes are employed to reclaim elements from these dry cells. Metals such as mercury, zinc, iron, nickel, cadmium and manganese are recovered using thermal processes. The mercury is often placed back in batteries, but a good amount also goes into measuring instruments, electric relays, lamps and other products.

Many states now have laws against placing batteries, especially lead-acid, into their landfills. In these states, private corporations and government agencies have special programs to collect and recycle the batteries. By 1991, 38 states had legislation that focused on the disposal of lead-acid batteries (RCO, 1992).

Glass

Glass is a material with thousands of uses, plus it is easy to recycle. Glass never wears out and can be recycled indefinitely. Approximately 8% of our municipal garbage is glass and the state of New Jersey ranks first in the amount of tonnage being recycled (Goldstein and Glenn, 1997). Since glass is a widely used material in our society, it is important that it does not end in landfills. For every ton of glass recycled, we save 1,330 pounds of sand, 433 pounds of soda ash, 433 pounds of limestone, 151 pounds of feldspar, plus eliminate 384 pounds of mining waste. Additionally, when we recycle glass rather than producing it from raw materials, air pollution is reduced by 14 to 20% (Earth Works, 1990).

The recycling of glass takes place in cities and towns in North America and on other

continents. All major metropolitan areas employ curbside pickup. San Francisco (1997), which has a very active recycling program, recycled 17,000 tons of glass in 1993. This amounted to 28% of the 60,000 tons used in the city. When compared to cities in Germany, which average almost a 40% glass recycle rate, American cities have room for improvement.

The majority of recycled glass goes back to packaging, primarily jars and bottles, but there are also other markets. The city of Oberlin, Ohio uses mixed color recycled glass in road construction ("City Uses," 1997). Glass cullets provide a nontoxic, sub-base material that is nonreactive and strong when compacted. Using a formula of 30% glass cullets mixed with 70% limestone, Oberlin officials calculated that the 125 tons of glass they used in their road project in 1996, was equal to the amount of glass recovered at curbside in their community in one year.

A Japanese corporation recently opened another market for recycled glass. Through research, they developed a new tile product made from recycled glass and clay. These new tiles are neither a stone or porcelain material, but a totally new category of materials. The tiles exhibit superior performance, color and quality above tiles made with just clay. Crystal Clay (1998) believes their product makes it possible to reduce the amount of clay usually mined, thus extending a natural resource and lessening the impact on landfills.

Paper

The wood fibers from which paper is made, make it an easily recyclable material. It is estimated that 40 to 50% of our waste stream is in some form of paper and we manage to recycle about 25 to 30% of that. This means that our public landfills contain about 36% waste paper products.

Paper products are classified into categories such as: newspaper, writing and printing paper, tissues and towels, corrugated goods, combination box board (cereal and tissue boxes, etc.), kraft paper and molded products (egg cartons). Many of the products in these categories were manufactured with recycled paper. Newspapers are a good example. They are recycled over and over to make new newsprint. Of the 12.8 million tons of newsprint used in the United States in 1992, approximately 1.4 million tons went back into the manufacture of new newspaper (Institute of Scrap Recycling Industries, 1997).

Companies that produce paper towels and tissues rely heavily on recycled fibers as do an increasing number of manufacturers of high quality printing and letterhead papers. The cereal box that you open in the morning has a high content of recycled paper, often 100%. Construction products such as gypsum wallboard, roofing paper, flooring and padding use recycled paper. The same is true of the brown kraft paper that is used to make the bags to carry groceries.

Schools throughout Canada and the United States have lunch cafeterias for students. One beverage that is always available in these cafeterias is milk. The milk is packaged in paper cartons, which when empty are discarded and end up in the landfill. Beginning in 1989, school districts in Los Angeles; Middlestown, New York; and Williamson, Tennessee launched milk carton recycling programs (RCO, 1992). With the aid of International Paper and selected recycling companies, the recycling program proved financially feasible. Researchers developed methods to separate the plastic coating from the paper fibers and enabled recycle companies to

sell both materials on the market. This technology provided a win situation for the schools, communities, businesses and environment.

The recycling of paper and paper products has been an environmental success. Even though paper consumption has increased, less is being dumped into landfills. Paper mills in the United States increased their use of recovered paper from 31.4 million tons in 1995 to 34.3 million tons in 1996. The added 2.9 million tons was the largest single annual increase in history (American Forest & Paper Association, 1998).

Steel

No material in America is recycled more than steel. Annually, it accounts for more than glass, paper, plastic, aluminum and other metals combined. In 1966, the people of San Francisco recycled over 1,000 tons of steel through residential curbside pickup. Impressive as it sounds, city administrators indicated that it was less than 20% of the steel waste generated by residents of their city (San Francisco, 1997).

Steel cans serve as containers for food products, paint, polishes and solvents. Because of their wide use, they provide a convenient source of steel for recycling. Most steel cans also contain a thin coating of tin. This metal is also recovered and recycled. Steel cans make up a significant part of curbside recyclable materials.

The iron and steel in automobiles is a big recycling source. Although cars are complex structures, their yearly recycling rate is close to 100%. Iron and steel make up about 70% of the components in the average automobile, and this valuable commodity has been part of the recycling infrastructure for years. The Steel Recycling Institute (1997) reported that in 1996, enough steel from old cars was recycled to produce almost thirteen million new automobiles.

Other recycled products contribute additional steel for the mills. Steel belting and wires used in vehicle tires are a high-quality source. Appliances also fit into the loop. Their mechanical and electrical components, which are often encased in steel bodies or shells, are an inherent part of our lives. Ranges, refrigerators, freezers, washers and dryers contain a high percentage of recycled steel that is recycled over and over.

The construction industry uses many steel products and much of the metal is from recycled items. Multi-family housing, retirement homes and single-family homes are employing increasing amounts of steel materials. Light weight steel framing was installed in an estimated 55,000 homes built in 1995, and that is expected to significantly increase by the year 2000. About 25% of all new homes built by the end of the 1990s will be totally or partially framed in recycled steel (Steel Recycling Institute, 1997).

Other Metals

Along with aluminum, other nonferrous metals are included in recycling efforts. The high market value for copper guarantees that little goes to landfills. Copper has an advantage over many other metals because none can match its ease of recycling. Copper recovered from scrap is as usable as primary copper refined from ore. Forty-three percent of the United States annual need comes from copper scrap.

Lead is another nonferrous metal that is recycled. The United States depends on this recycled material for 55% of its annual need. It is recycled back into products such as lead-acid

batteries, sheet lead for shielding and solder alloys. The amount of zinc that is recovered form scrap is much less than copper and lead. One primary source is mercury/zinc batteries. Only 19% of the annual United States need of zinc comes from recycled materials.

Plastics

Plastic is a manmade material that is not usually biodegradable. Microorganisms such as bacteria and fungi cannot penetrate plastic and do not break it down. Sunlight and oxygen will eventually cause plastic to disintegrate, but these things are not available in the depths of landfills. Because of the stability of plastics, they are employed for a wide range of applications. Approximately 30 plastic resins are now in use, which provides a challenge for recyclers.

Most plastics are technically recyclable, however, less than 3% of the annual 60 billion pounds are actually recycled. In 1992, plastics occupied more than 20% of landfill space nationwide (San Francisco, 1997). This does not bode well for the future, because by the turn of the century, the Environmental Protection Agency estimates that one quarter of our garbage will be plastic.

The Society for the Plastics Industry uses a labeling system to identify types of plastics. Located on the plastic product will be recycle arrows with a number from 1 to 7. The number identifies the plastic resin used in the manufacture of the object. They are: #1 polyethylene terephthalate, #2 high density polyethylene, #3 vinyl/polyvinyl chloride, #4 low density polyethylene, #5 polypropylene, #6 polystyrene, and #7 other plastics. These plastics are very often recycled back into the same items from which they originally came. The list includes bottles, pipes, trash cans, clear food packaging, stretch wrap, trash bags, egg cartons, and carpets.

Recycled plastics have found another market in the area of composites. Companies are currently producing a product that is referred to as plastic wood. This is a mixture of several types of recycled plastics that are heated, extruded and formed in molds. The product is substituted for traditional lumber in selected uses. These products are available for home improvement, architectural projects and other uses where durable, long lasting wood was needed. Examples of plastic wood products include fence posts, benches, pallets, railroad ties, guard rails and parking bumpers.

Rubber

The major source for rubber recycling is transportation vehicle tires. The disposal of tires on a global scale has been of increasing concern to industrialized countries. According to the Rubber Association of Canada (1997), less than 5% of tires worldwide are currently being recycled.

Some companies that recycle tires will cut them into pieces and then stamp parts from the tire sidewalls. These parts are then assembled into new products such as door mats, handbags or floor coverings. These are low technology operations and the market for these products remains relatively small.

The greatest demand for recycled rubber is in the form of granulated or "crumb rubber." Whole tires are reduced through a mechanical shredding process or they are frozen and then shattered. The rubber, fiber and steel are then separated. Rubber from this process can be used

for a variety of products such as bonding tape, carpet underlay, footwear, irrigation pipes, recreational surfaces and joint and crack sealants.

However, the greatest demand for crumb rubber is now coming from road construction companies. It is used as an additive in an asphalt cement mixture for paving roads. A one mile stretch of highway, using a 3% rubber mix, will consume 12,500 scrap tires. Although this mixture has been approved by the U. S. Federal Highway Administration and the Environmental Protection Agency, some experts are withholding their approval. Concern exists about long-term performance and air emissions from the processing plants as well as the future recyclability of the end-product.

Demand for products that contained ground rubber increased throughout the 1990s. About 400 million pounds were sold in 1996 and the 1997-98 projection was a 15 to 20% increase (Blumenthal, 1997). The increased demand was aided by the identification of additional uses of old tires and crumb rubber.

The state of Maine has experimented with the use of rubber chips for road underlayment. A 12-inch layer of chips was placed under 18-inches of soil and gravel in an effort to combat frost upheaval. The equivalent of 20,000 scrap tires were used for a 600-foot section of the road, and the experiment appears to be working ("Pushing the Scrap," 1996). The University of Maine at Orono used tire chips as a backfill behind a campus retaining wall. The advantages of using the chips over gravel is that they exert less than half the pressure on the wall and were less expensive.

Textiles

The recycling of textiles takes place on a limited basis. Carpet fibers are the primary source for this segment of products. DuPont, BASF, Monsanto and other companies recycle old carpets into new products. Nylon and vinyl backing from old carpets is recovered and turned into new carpeting, automotive parts, highway sound barriers, industrial flooring, and marine bulkheads. Some textile companies are also using recycled plastic from soda bottles in their products. Several manufactures of denim and outerwear are spinning the melted plastic into yarn which is then woven into blended fabrics (Morrissey, 1997).

Atlanta, Georgia is the home of another company that combines textiles and recycled plastic. Their product is a reusable cloth shopping bag that is made of canvas, cotton and post consumer recycled soda bottles. Regard for the environment was the driving force behind the development of this product. The Cloth Bag Company (1997) was concerned about supermarket industry estimates that the average consumer used 500 disposable paper and plastic bags per year and many of them ended up in our landfills.

Wood

Wood waste comes in a variety of categories and from many different sources such as residential, industrial, construction and demolition, and the forestry industry. The waste may have a high moisture content, or no moisture at all. Categories of waste would be sawdust, shavings, bark, chips, branches, framing lumber, moulding, hardboard, pallets and skids, concrete forms, guard rails, poles and Christmas trees. These wood waste items are recycled through refurbishing, processing, manufacturing, composting, and incineration for energy.

Refurbishing is the act of cleaning and repairing the wood product without necessarily making a new or different product. The pallet industry is involved in much refurbishing. Grinding or chipping wood to prepare it for further manufacturing would be processing. A significant amount of wood waste is recycled in this manner. The manufactures of particleboard and fire logs consume processed wood for their products.

Composting is another area that utilizes processed wood chips and wood fiber. This material is popular for landscaping purposes around the home. The organic material holds heat in the ground, discourages weed growth and is aesthetically pleasing.

Incineration is also associated with wood recycling. Some manufactures who produce products from wood, will use sawdust and trimmings to obtain energy. Boilers are employed to harness the energy which is then used to produce steam for heating and electrical power generation. One company in Oregon has turned other companies sawdust and shavings into a multimillion dollar business. They convert the waste into fuel pellets, logs and barbecue briquettes. Using a mixture of 70% Douglas Fir and 30% western Red Cedar, the pellets and logs produced, burn hot and create little ash or air pollution (Christianson, 1997).

Treated lumber has presented a problem for companies wishing to use it in recycling processes. Chemical contamination along with glues, paints, and urea formaldehyde resins limit what this type of wood waste can be used for. This problem will continue to grow because it has been estimated ("Recovering," 1997) that six million cubic meters of treated lumber is discarded each year. Only a very small amount is currently being recycled into landscaping and pole beans.

Wood waste has also been used in the development of composites. Wood fibers are combined with cement to form a material that improves acoustics and insulating properties. This composite is made into highway sound barriers and wall forms. Wood has been combined with plastic for other products. Windows and doors are being made from 40% wood residues mixed with vinyl. This composite is claimed to be better than wood (Lavendel, 1996). Other products made with the wood and plastic combination include chairs, hangers, paint roller handles, bicycle bottle holders and scissor grips.

Miscellaneous Items

Industrial and residential waste comes in all sizes, shapes and materials. This section of the paper will review the recycling of a few unusual or uncommon products.

Parents often invest thousands of dollars for orthodontic braces for their children's teeth. Because of the cost of these items and their durability, several U.S. companies have recycle/reuse programs. Orthodontic bands and brackets have been in the reuse loop for about ten years. The companies use a refurbishing process where old parts are re-etched, sand blasted and cleaned. Orthodontic specialists can save about $720 per patient on the cost of hardware when they choose the recycled/reuse items over the cost of new bands and brackets (Orthatronics, 1997).

A new composite panel board material has recently been developed from agriculture waste. The product, called Plastron, is manufactured by combining plastic waste, wheat straw, rice hulls or other agriculture wastes (Royce, 1997). The board is lighter in weight than particleboard and can be used in many of the same ways which particleboard is typically applied. It was scheduled to be available to consumers in late 1997.

Old movie film contains emulsions and cellulose triacetate plastic which can be recovered and used for new products. Through chemical process, these materials are captured and used to produce pigments and cellulose diacetate. Plastic reels, toothbrush handles and combs are manufactured from the cellulose diacetate and the pigments are used in the production of a variety of objects (NHW Systems, 1997).

Fishermen in the Pacific Northwest dispose of 500,000 pounds or more of old nylon gill net each year. Putting this material in landfills created problems because it often ensnared equipment operated by landfill workers. Several communities are now collecting the old nets and sending them off to be recycled into useful products. In 1992, three years after the net program was established, Recht (1997) reported that 47,000 pounds was marketed overseas and made into bicycle seats.

Integrating Recycling Into Technology Education

The population of the world continues to grow and as it does, the demand for products increases. This demand has brought about the need for new and better ways to handle waste. Numerous products we purchase have a limited life, and then enter the waste stream. Controlling and limiting the waste stream is a global problem that all of us need to be aware of.

Environmental literacy is a subject area that the U. S. government has taken great interest. In 1990, Congress passed the National Environmental Education Act which focuses on increased public awareness and understanding of the natural environment. It also encourages partnerships among schools, industry, state and federal agencies, and private organizations. The long-term goal of this legislation is to provide the citizens of the U. S. with the knowledge and skills necessary to make informed decisions about the environment.

Recycling and waste management is an integral part of any environmental program and is subject matter in some technology education programs. Important concepts about pollution, waste prevention and recycling can be taught as a stand- alone unit, or dovetail into areas of construction, manufacturing, energy and transportation. There is no better place to bring these concepts to the attention of students than in technology classrooms and laboratories.

According to Rockland (1995), among the ten critical issues affecting youth today, and things they personally would like to improve, solving environmental problems was second, behind only AIDS. If the environment holds this high priority on their list, it should be an area that grabs attention and holds their interest. However, just talking about environmental problems will not keep their attention for long; they need to become involved. This is where the hands-on approach in a technology laboratory can make a positive difference in the understanding of concepts and principles.

Teachers can obtain a wealth of information about recycling waste management and environmental education from the U.S. Environmental Protection Agency (EPA). The National Consortium for Environmental Education and Training utilizes EPA funds to help prepare teachers to make environmental education part of their classroom instruction. The organization provides workshops, publications and links to resources through Gopher/World Wide Web sites on the Internet. The International Technology Education Association has put together a series of

curriculum briefs dealing with waste management. Much of the information you gather from these sources can be integrated into technology modules and units of study.

During the twentieth century, our nation has enjoyed impressive progress in all fields. This progress has been aided and driven by the tools that technology provided. If this progress is to continue, technological literacy is a must for future generations. They will need to give closer attention to the impact of technology on their environment and understand the vital role that recycling and reusing plays in the ecology of the planet.

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INTERNET ACTIVITIES

The following list of sites provide activities that focus on recycle/reuse and energy savings areas. The activities are suitable for students in grades 6 thru 12. Addresses were active in February 1998.

Be A Garbage Detective

A quiz that has students investigate the ways to reduce the waste stream, reuse materials and recycle. http://www.sfrecycle.org/v2/quiz/quiz1.html

Dumptown Game

An educational game where the student assumes the position of City Manager. Object is to clean-up the town through various recycling programs.
http://www.epa.gov/recyclecity/gameintro.htm

Energy Quest

The California Energy Commission has put together this site to help students learn about energy and conservation. http://www.energy.ca.gov/educational/index.html

Environmental and Recycling Activities

The site has a number of activities designed for students in grades 7 thru 12.
gopher://eelink.umich.edu:777/11/activities/cornell/7

Home Made Paper Recipe

A list of equipment needed and the steps to follow to produce paper from recycled materials. http://www.web.apc.org/rco/factsheet/fs_d07.html

How to Set Up A Recycling Program at Your School

Provides general information of recyclable and types of containers for collection of items.
http://www.sfrecycle.org/v2/sch/assist.html

Personal Environmental Impact Calculator

This site provides an easy way for students to gain a perspective on some of the environmental impacts of their daily activities.
http://fatman.neep.wisc.edu/~ans/sama.ies575/personal.impact.html#index

Plastics Resource

A review of information on plastics and their impact on the environment. Special section for students and teachers.
http://www2.plasticsresource.com/Docs/apc...grade_st.htm

Quest of the Ring Leaders

An environmental education program set in an adventure game format.
http://www.ringleader.com/quest/instructions.html

Recycle City

Students can explore how this city's residents recycle, reuse and reduce waste materials.
http://www.epa.gov/recyclecity/mainmap.htm

Recycle Pennsylvania Computer Mousepad

Opportunity for students to obtain a free computer mouse pad made from recycled material.
wysiwyg//83/http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/DOCUMENT/mousepad.htm

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