RECYCLE

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Recycle

Ask a person what he or she is doing to help the environment, "I recycle" will likely be the answer. There may be steps further up the waste management hierarchy, but recycling is the most famous. It is fashionable to use a *Blue Box* or *recycling depot*; people take pride in diverting goods out of garbage bags and away from landfills. The terms *recycle, recyclable, and recycled* have become household words. But when asked what happens to the material that is collected for processing, "I am not exactly sure" would be the response.

Recycling
is the separation of materials
for use as raw materials in manufacturing,
to meet market demands.

There has been a boom in the number of people, municipalities, and businesses involved in this form of waste reduction. Unfortunately a lot of unanswered questions have arisen, such as how did the process get started? What can and cannot be recycled? Where does the material go after it is collected? How is the material separated? Do markets for the materials exist? What do the little symbols and numbers on the bottom of containers signify? The answers to these and other inquiries will be given in the following pages.

An old adage states "a little knowledge is a dangerous thing." Everyone knows about recycling but few people understand recycling. By taking a closer look at what really happens after a Blue Box or *depot cart* is emptied, the entire process will be more effective. Knowledge is the key to success in any endeavour.

History of Recycling

Recycling is considered to be a phenomenon of the last part of the 20th century. It is another example of modern science and mankind's ever increasing knowledge. This is an incorrect assumption. The Blue Box and other collection systems may be new but recovering valuable material from the waste stream has been in practice since humans first walked upon the Earth.

Ancient peoples recycled out of necessity. A cave man might catch an animal once a month. It may have taken several days to trap the beast. Food, clothing, tools, utensils and other items were all provided by the flesh, bones, and hide of the animal. Only the truly useless parts were discarded. In North America, the aboriginal people were still practising these same Earth friendly techniques when Europeans arrived in 1492. Agriculture and other innovations were present but native people continued to respect nature and make full use of the gifts the land, air and water provided. Some explorers from more "civilized" nations saw these people as savages but these "barbarians" were the truly advanced people.

The influence of Western European beliefs saw a change in attitudes. Nature was to serve man. Its resources were to be harvested. Great empires sought to expand their boundaries in search of riches. Newly discovered or conquered areas were stripped of their silver, gold, fish, timber, and other treasures all in the name of king, queen and country. Reduction or recycling was used simply to overcome short term problems or difficult times. Warfare is one such time where the unrestrained consumption of material is interrupted and available resources are better used.

The Second World War was the birth place of the waste problems that we are now trying to overcome. Raw materials and resources became scarce during the conflicts of the 1940's. Citizens were asked to help by donating their aluminium or similar material. The pots and pans were recycled to become aircraft, vehicles, ships, rifles, and munitions. War also has a tendency to accelerate the discovery of new technologies. While the public were gathering old resources, scientists were inventing ways to produce new ones. From a waste stand point, the biggest breakthrough of World War II was the advent of synthetics and plastics.

These two materials were used to make light-weight, convenient and disposable rations and other supplies for troops. After the war, the manufacturing of disposable items switched from "*C rations*" to *T.V. dinners.* The number of throw-away products and amount of convenience packaging kept escalating. At the same time, governments, especially in North America, urged people to buy products; it was good for the economy.

History of Recycling (cont.)

Years of rationing meant the public was more than willing to participate in this boom. The new technology, attitudes and habits that came out of the post-war decade, set in motion the waste trouble that we face today.

Legislation and other actions to correct our present waste problem are just beginning. Organized recycling is part of the solution. Across the world, people separate and clean the recyclable portion of their waste. Recycling may be third in rank according to the waste management hierarchy, but it is the most tangible. People can see the results of their efforts. A sense of accomplishment is felt and as a result a person is more likely to participate in other waste reduction methods. Although it is not perfect, recycling is a catalyst for diminishing our environmentally harmful lifestyles and habits.

Modern Recycling

In Ontario modern recycling is synonymous with the Blue Box. As of December 1992, three million homes were served using a Blue Box collection system. Although the blue plastic container is a household fixture, few people know its history. Although there is no clear definition of how the Blue Box started, the following events occurred at the time when most people believe this type of recycling system first appeared. The two gentlemen credited with starting the Blue Box program in this province are Nyle Ludolph and Derek Stephenson. Mr. Stephenson was a recent university graduate when, in 1974, he and some colleagues formed a charitable organization called Is-Five. The group started using a pick-up truck to collect recyclable goods from residents in The Beaches area of Toronto. They conducted a similar trial project in East York. Eventually Is-Five transformed into Resource Integration Systems (RIS) Limited; a profit generating descendant of the original organization.

In 1981, RIS approached Laidlaw Waste Systems Limited to participate in a six month recycling pilot project in the City of Kitchener. Laidlaw's representative was Mr. Ludolph known as "the father of Blue Box recycling". Together Ludolph and Stephenson devised a program for approximately 1000 homes. The households were divided into four groups. A different method to promote recycling was tried in each: promotional materials were used in one area, different pick-up days in another, working through community associations in yet another. One group received something Mr. Stephenson had seen during the 1970's in British Columbia; a plastic container. Newspaper, steel food cans, glass and other paper were all collected in the box. Pop cans at this time had an aluminium top mated to a steel bottom so they were not sought. The plastic container out performed all other methods. In September of the same year, it was decided that containers should be used city wide.

In order to serve Kitchener 35,000 containers were needed. Despite its success the original container was not entirely suitable. After some fine tuning the container we all recognize today appeared. Why the colour blue was chosen is still something of a mystery. One rumour says the colour was chosen because the provincial government in power at the time of the Kitchener trial was the Progressive Conservative party.

History of Recycling (cont.)

Another tale states that when Mr. Ludolph went to choose a container he had his pick of three colours: white, black or blue. For no deep-rooted or special reason Mr. Ludolph selected the blue box. Seeing as this story came from "the father of Blue Box recycling" himself, it would seem to be the correct answer. Recyclers have stayed with the colour blue because it is easily distinguished from its surroundings. In summer, the blue allows the boxes to be spotted against the greens and other earth tones of the season. During the winter, the container stands out against a background of snow and ice. Blue is also an aesthetically pleasing colour to most people; few would object to having a Blue Box in their kitchen or garage.

Dispersal of the Blue Box across the province was fuelled by many factors. Growing environmental awareness was and still is one of the biggest influences. The cost of landfilling waste is another reason for municipalities to seek waste diversion methods. Another major influence was the soft drink industry. The Ontario Soft Drink Association wanted to increase the percentage of non-returnable soft drink containers. More specifically, bottlers wished to increase the percentage of cans being sold and replace large capacity glass bottles with safer two litre plastic containers. What followed was a long series of political and legislative arguing and consultations between government agencies, environmentalists and soft drink producers. Although much debate still rages over the outcome, the most important point is a deal was struck by the federal government, individual municipalities and the soft drink industry, through Ontario Multi-Material Recycling Incorporated (O.M.M.R.I.). Each agreed to pay one third of the cost to start a Blue Box program in municipalities across the province. This deal was instrumental in helping the Blue Box spread into more and more Ontario homes.

Some people feel the aforementioned deal is more than fair; others see it as a way of passing-the-buck. Regardless, recycling has proven to be a viable means of diverting waste from landfills and raising public awareness; the little blue containers help educate people to adjust their lifestyles and habits. Most of the deliberation surrounding Blue Box systems revolves around who should pay for the service; the public who use the cans and other materials or the manufacturers producing these materials? This is one area where careful consideration of the facts is needed.

Some areas or situations render a plastic box undesirable. An alternative is the Blue Bag. One version of this is a blue transparent plastic bag used to hold mixed recyclables. Like a box, the bag is left at the curbside. Collection can be carried out in conjunction with garbage pick up or separately. Most Blue Bag systems resemble garbage collection; the bags are loaded into the collection vehicle and then compacted . This can lead to the negative aspect of bagged recyclables. Depending upon the mix of materials being gathered, too much compaction can create contamination. Glass can break making its way into plastics or metals. Liquids trapped in cans and containers can cause paper products to become wet. There is also the problem of opening the bags at the separation facility, dividing the compacted materials and deciding who should pay for the bags.

History of Recycling (cont.)

A second version of the Blue Bag is the reusable nylon bag; a large box is not ideal for all situations. It would be extremely difficult to collect all the Blue Boxes in an apartment building. Most high-rises use depots to gather recyclables. A nylon bag provides a convenient way to transport material to a building's depot. For smaller households with less people, for example retired couples, a Blue Box may be too large. People in this situation may only fill a box once a month at which time the box may be too awkward or heavy to place at the curb. A bag allows the materials to be carried to the road easily.

Like so many other areas in modern history, recycling seems to be changing at a pace that would have been considered ridiculous just a century ago. Modern recycling is evolving at such a rate that it would require a weekly re-write of this book to keep up with the changes. The important thing to remember is where it all started.

Nature works in cycles. The greatest of the ancient civilizations understood that man did not make the cycles, but was simply a part of them. In a push to evolve, we have forgotten our place. What happens to one portion of a cycle affects all others. Recycling is an attempt to strengthen the Earth's cycle, strained by our wasteful practices.

Collection

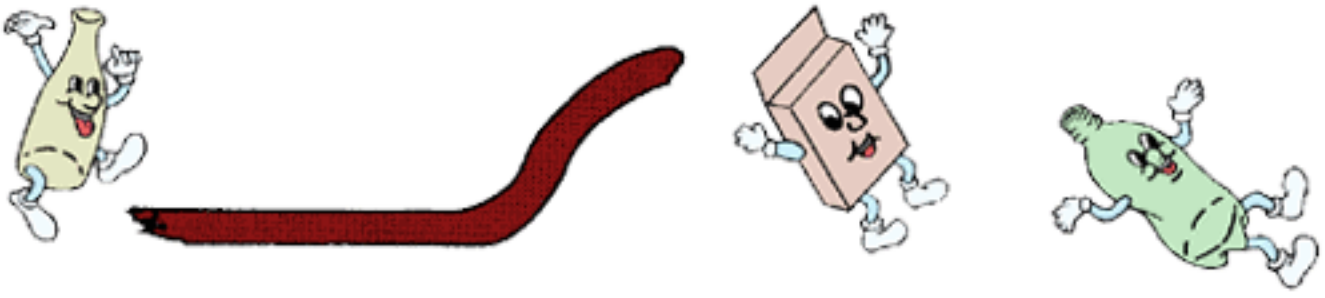
Collection is a vital link in the recycling chain. It joins the people separating recyclable goods to the people who use these goods. A collection system can make or break a recycling program. Efficient and convenient collection is apt to generate higher participation levels. However, proper gathering of recyclables does not have to be an elaborate or expensive endeavour.

Classifying collection is based upon the degree of technology involved. The three classes are called low, medium and high-tech. The class to be used is based upon considerations such as available capital, number of homes or businesses to be served, physical distribution of these customers, available markets and other factors. Starting with low-tech systems, we will look at examples of how the cans, bottles, and other items the public diverts from their waste, are gathered.

Low-Tech

The classic example of a low-tech system is the person seen at the roadside, in the park, at the beach and in other public places scouring for recyclables other people have thrown away. He or she exchanges these goods for money. In the province of Ontario, beer bottles are worth 10 cents each, when returned to The Beer Store. Most areas have refundable deposits on a degree of soft drink containers. Some recycling centres pay people for the material left at the centre. Casual collectors alone, could not recycle all the bottles and cans in the world, but they gather material that may escape other collection methods.

There is a tradition in North America called the bottle drive. Boy Scouts, churches, civic organizations, schools and other groups go door to door asking for donations of bottles, cans and other recyclables. The collected material is returned for refund, bought back by recycling centres or sold directly to the companies re-manufacturing the products. Money raised by this low-tech system is either used by the group (for trips, renovations, etc.) or donated to other charities. Bottle drives can



Collection (cont.)

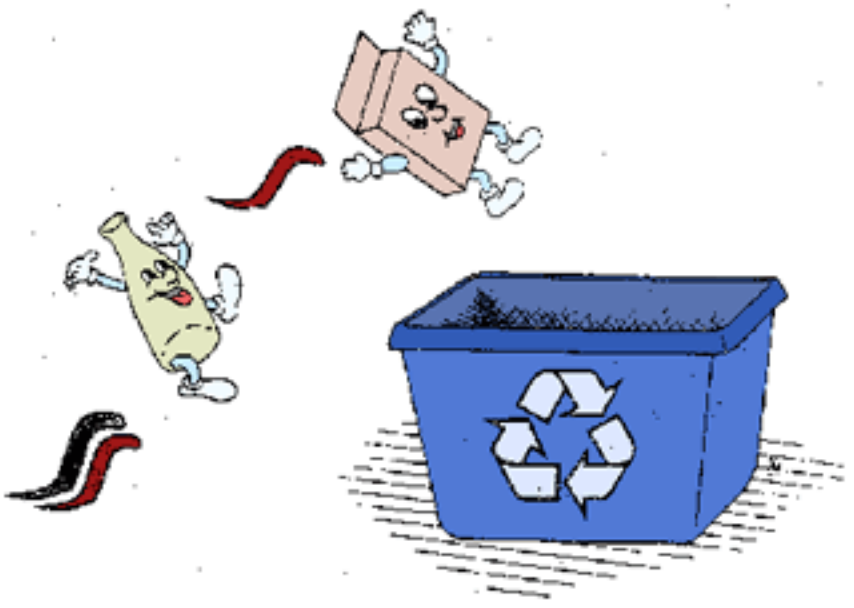
be periodic events conducted by one Girl Guide company or regularly scheduled occurrences helping charities to meet a funding goal. Despite being relatively simple in operation, drives put potential waste to good use in the community.

Possibly the most organized form of low-tech recycling is the depot. Instead of the collectors going to the public, the public delivers recyclables to the collectors. Staffed recycling depots are facilities where a person drops off recyclables. The donor is reimbursed, depending on the weight and value of the material, or simply leaves the goods for free. Industry, municipalities or private contractors may sponsor this type of depot. Some facilities are manned by charities who receive the profit from the products collected. Others are staffed by volunteers trying to help the environment. Staffed depots are inexpensive to operate but they do not generate the same participation or diversion rate as more advanced systems. Cheaper still are unmanned depots. However, there is a risk of a higher level of *contamination* among the recyclables.

Medium-Tech

Slightly more advanced collection can be had in medium-tech systems. The basic method involves pick-up trucks, trailers or flat-bed vehicles. Recyclables are collected from house to house. Material is tossed into the back of the vehicles then hauled away. When the number and quantity of items is kept low, this system is fairly efficient. If either variable increases, problems arise. First, consider an increase in the number of items. Because there is no separation at the time of collection, material can become contaminated. Broken glass can mix with plastic; coloured glass can be found in clear glass. Markets for contaminated material are almost non-existent. Technology to divide materials and remove contaminants is available but it is costly. An increase in the amount of material a medium-tech program handles would soon overload the system. The number of trucks or number of trips per truck would rise, once again eliminating the low cost and simplicity of the system.

Side-loader trucks try to combat the contamination issue. The body of the truck is divided into sections. Individual or groups of recyclables are manually loaded into a designated section. Paper and cardboard might go in one area, metals in another and plastics in yet another. As the material in each compartment grows, the opening on the side of the truck is reduced to keep the recyclables in the vehicle. If the recyclable items are light, then lifting them hour after hour may not be too strenuous. Heavy articles like glass containers and paper can soon tire the collection workers. As more material is placed in a section, a person has to lift higher. Injuries can occur, again, depending upon the type and amount of material collected.



Collection (cont.)

High-Tech

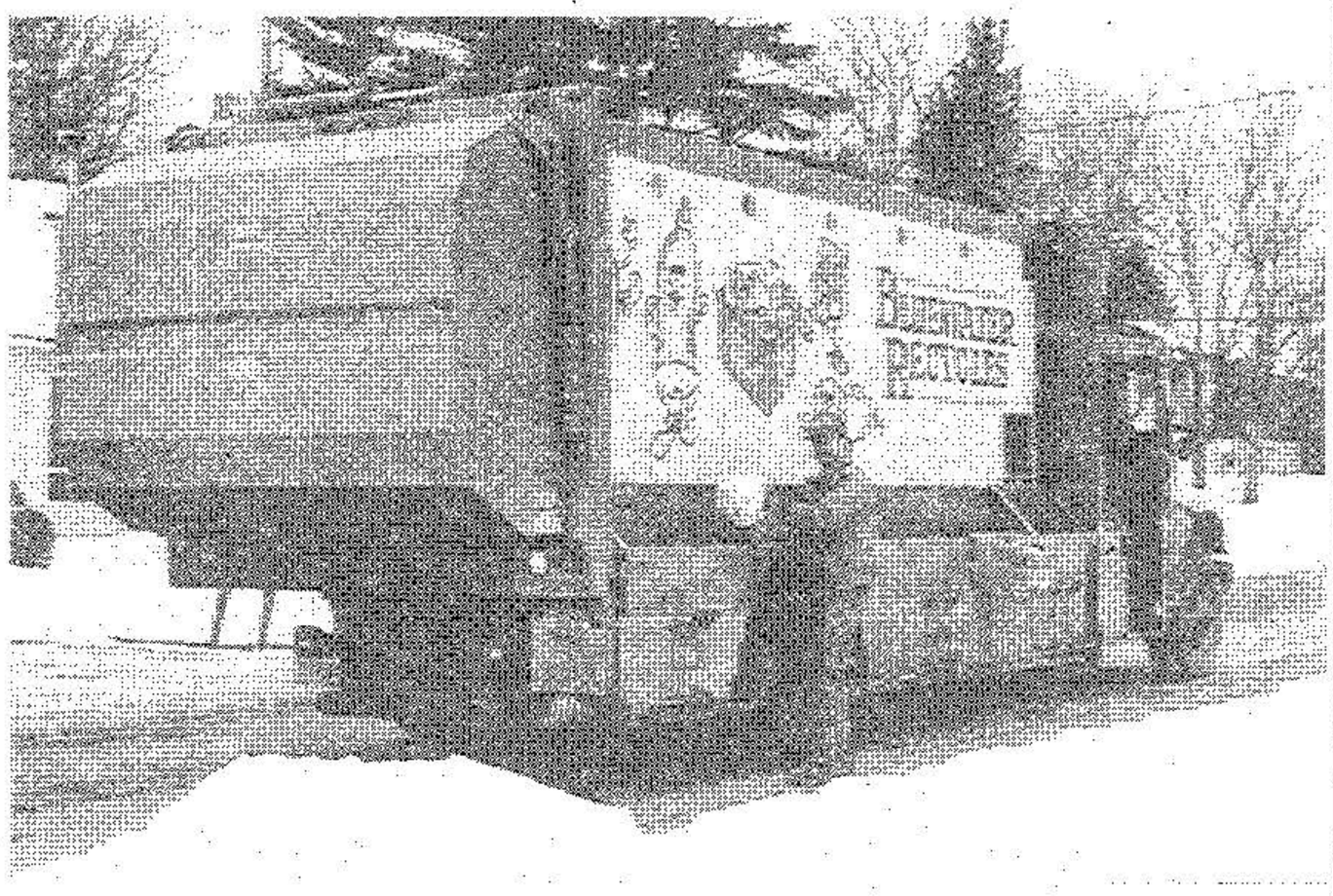


Figure D-1

High-tech collection attempts to strike a balance between cost, convenience, efficiency and safety, by using a mechanized truck. Only one person is needed in its operation. The machine is equipped with two steering systems. While en-route from one area to another, the driver sits on the left side of the cab. Upon reaching the destination, the driver operates the right hand stand-up controls. He or she stops, then steps out of a sliding door to grab the recyclables. The material is separated and placed in bins along the side of the truck (Figure D-1). When the bins are full they are mechanically lifted to the top of the vehicle, the roof opens and the contents are dumped in four adjustable compartments (Figure D-2). The bins are lowered and the driver continues along the route.

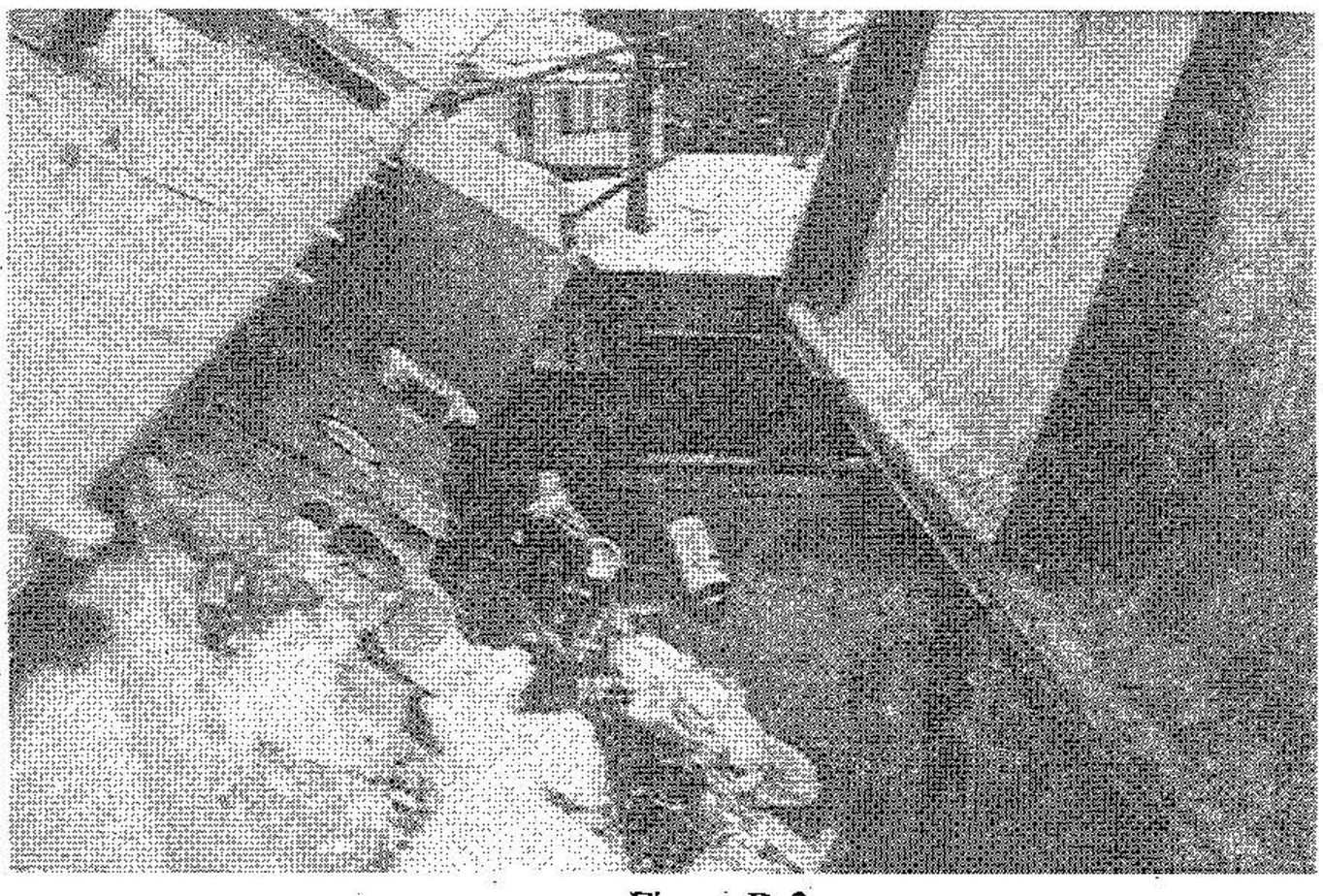


Figure D-2

The optional compartment size means a vehicle can be tailored to meet specific needs. For example, an area may produce twice as much paper as metals. Adjusting the compartment to compensate for the increased paper means each section would be full at approximately the same time. Collection is more efficient, as a result. Contamination is kept to a minimum because the material is easily divided and stays that way. This also helps in any further processing. The placement and operation of the bins reduces worker fatigue. Lastly, these trucks make recycling highly visible and professional. Before setting up collection based upon high-tech equipment, it is important to establish whether the materials collected and the number of customers justifies the cost of the equipment.

Future collection techniques will be dictated by how waste is separated. Today the most common method is source separation; recyclables are removed before entering the waste stream. Other options include wet/dry separation and no separation (removing recyclables from mixed garbage after collection). No matter how advanced or different collection becomes, one thing will not change. The method used must be the one best suited for a particular area. Efficiency is more important than technology.

Separation

In terms of recycling, separation is the organizing of collected material. One of the definitions of the word organize is "to prepare". Recyclables are processed in a manner that prepares them to meet *market demands*. This processing involves the distinguishing and removal of one or more recyclables from the total material gathered.

Like collection, separation is gauged by technology. The range of equipment includes everything from advanced electronics to second hand machinery especially adapted for recycling. The technology used is a function of many different variables. Perhaps the most important one is how the material arrives at the separation facility. Is it source separated first or collected as mixed garbage? Having the recyclables divided at the point of generation helps reduce the amount of further separation needed and lowers contamination. The quantity of material being separated, the number of products being removed, who is doing the separation (private contractor, municipality, etc.) and economics are other influences.

There are countless numbers of separation methods. Some businesses simply group material together, like mixed plastic or paper, and send them to another company for further processing. Other companies have recycling methods thorough enough to produce market ready materials. It would be impossible to explain them all, so we will look at a few interesting examples.

Let us start with a system most of us are familiar with. Recyclables are separated by the public, then put out for collection. A worker double-checks the material at the curbside, then loads the items into the appropriate compartments of a vehicle. The vehicle has four separate compartments for mixed metals and plastics, clear glass, paper products, and coloured glass.

At the processing plant, the content of each compartment is off-loaded into a distinct pile. Paper products move along a conveyor belt, where the workers first remove cardboard, *box board* and *kraft paper*. Other people stationed further down the conveyor check for catalogues, plastic bags, string, garbage and other contaminants. These items are removed and the remaining product arrives at a *"fluffer"*. Finally, the paper is compacted in a baler (Figure D-4) and bound, readied for shipping. Cardboard and other lower grade paper goods are processed in much the same way, except there is no need for a fluffer; the material can go directly to the baler.

Separation (cont.)

Figure D-3

A different production line separates mixed metals and plastics (Figure D-3). Paddles pull the *commingled* product to a conveyor. Stray glass and other undesirable products are removed manually. As the material drops over the end of the belt, a magnet removes steel containers. These are crushed then sent along another conveyor, checked, *densified* into *briquettes* and stored.

While this is happening, the aluminium and mixed plastic falls from the original conveyor into a rotating drum. Holes allow aluminium to drop out of the drum and onto yet another moving belt. After being checked, the metal is sent by forced air to a holding area. In general, plastic products are too large to fall through the holes, so they travel along the length of the drum, then fall on a final conveyor. The different types of plastic are hand sorted and sent to separate storage areas. A final magnet, at the end of both the plastic and aluminium conveyors, makes sure any errant ferrous goods are caught. When enough materials have been processed and stored, each type is sent to the baler, then stockpiled. By combining machinery and skilled workers, contamination is kept to a minimum.

The clear and coloured glass, brought to the facility, is also readied for market. Because glass can break after it is loaded onto the collection vehicle, the most critical role is performed by the driver. He or she checks for contaminants during the initial separation. Workers at the plant inspect both the clear and coloured loads for metals, lids, porcelain, mirror glass or similar undesirable material.

The type of system just discussed is a good use of relatively modest technology and people power. Machinery is used to perform heavy or simple tasks, while human beings carry out the more complex duties. Unfortunately the equipment is limited in the volume of product it can process. Sudden increases in the amount of material arriving at the facility can result in equipment failure. When

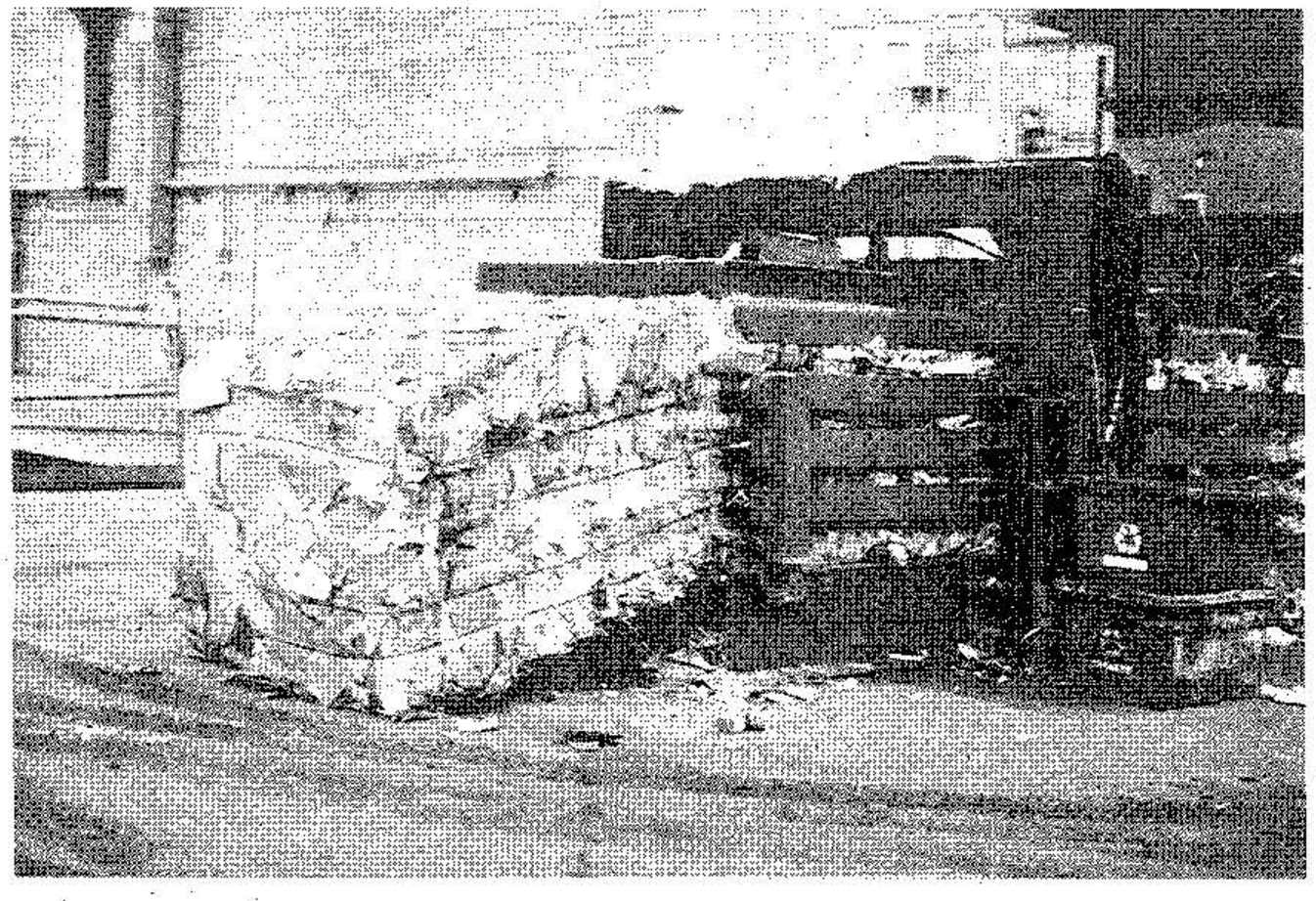


Figure D-4

Separation (cont.)

managed correctly and coupled to a good collection system, this type of separation can be a success. The Bluewater Recycling Association, in Grand Bend, Ontario, showcases what a facility of this type can achieve.

Technologically extensive separation facilities are truly fascinating. The machinery used is state-of-the-art in the recycling community. Most of the equipment was designed to be highly efficient at a specific task. The example we are about to explore is similar to a recycling operation found in Rhode Island.

Recyclables are source separated into two groups: paper and mixed materials. Both are collected at the curbside, then taken to the processing plant. Each group is tipped in distinct areas of the plant. The mixed materials (glass, plastics, and metals) are fed into a receiving pit. Computer sensors regulate the flow from the pit to an incline conveyor. The conveyor rises approximately 8 m enabling the recyclables to be gravity sorted. Workers at an inspection station, remove any non-recyclable items onto a reject conveyor. Materials left on the incline conveyor then pass under an *electromagnetic* belt. Ferrous metals are deposited in a chute then dropped onto a conveyor. The metals are sent to a shredder for processing to meet end market specifications. The rest of the commingled items ignore the magnet and fall onto a screening machine. Here, fine materials are shaken out as the plastic, aluminium and glass are divided into two distinct but equal streams.

Chain curtains move over the recyclables taking away the light products: plastic and aluminium. The glass is too heavy to be affected by the curtains; it travels to another screening machine. Broken glass and other small articles fall from the screen onto a recovery conveyor. This material is taken away for further processing. The rest passes over the screen and travels to the main glass line. Workers first remove the green glass into hoppers then do the same for the amber portion. By a process of elimination, only clear glass is left. Each colour is then sent along a separate conveyor to be crushed, screened once more and placed into individual concrete bunkers.

The light material that was removed by the chains, falls into a sorting machine. A bar screen stops larger plastic items from entering this equipment. Instead it moves to yet another conveyor. Plant employees separate each plastic based on resin type. *High Density Polyethylene* (H.D.P.E.) is dropped into a hopper then sent to be granulated. *Polyethylene Terephalate* (P.E.T.) is perforated and baled into 365 kg bundles. In the mean time, the light recyclables exit the sorting apparatus and are sent to be divided using opposing magnetic fields. Aluminium is forced by this field onto a different conveyor belt destined for a flattener. The compressed metal is blown by air directly into a trailer, ready for shipping.

After unloading the mixed products we have just

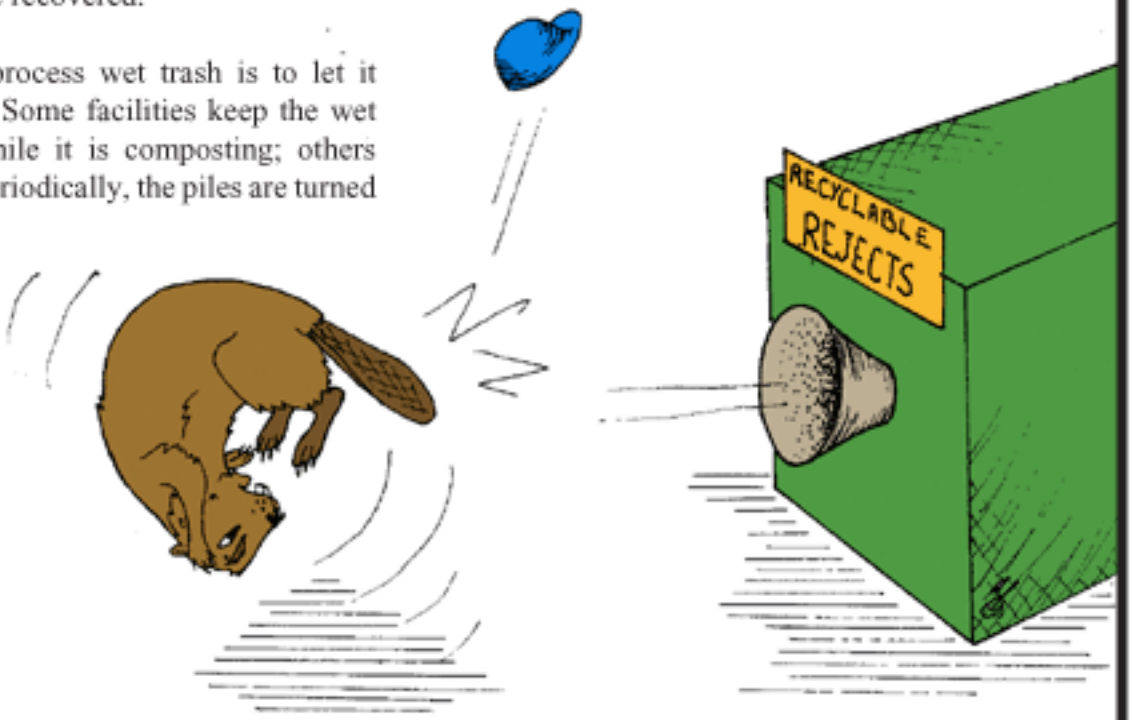
Separation (cont.)

discussed, the collection vehicle would empty the paper in another area of the processing plant. First, the material is visually inspected. A skid loader pushes the satisfactory paper into a receiving pit. Once again, a conveyor hauls the product into a baling machine. The 500 kg bales are bound and stacked. Optional equipment designed to separate the different grades of paper is available.

A sorting plant in Odense, Denmark, can take all recyclables in as one mixed product and separate the commingled material into individual components. Other high-tech processing machinery includes scanners, computers and compressed air. P.E.T., H.D.P.E. and P.V.C. (*Polyvinyl Chloride*) container pass over a sensor that checks to see if the container is clear or opaque. The computer is programmed to acknowledge P.E.T. and P.V.C. as clear, while opaque items are recognized as H.D.P.E. The first two resins are separated from the third by a burst of compressed air; the computer triggers a nozzle that blows the H.D.P.E. away from the other plastic. A second scanner checks the clear items for chlorine ions; chlorine is used in the making of P.V.C. The computer sends a message to another nozzle that propels the P.V.C. onto a different conveyor belt. The three different streams of containers are double checked for contamination by human workers. The downside of sophisticated machinery is, it is expensive to purchase. More importantly, it cannot think like an actual person.

Another system that stems from source separation is wet/dry processing. As the name implies, waste is collected in two categories. The wet portion is food waste and other *organic garbage* (some systems do not take yard waste due to the volume of material that would be received). The dry element is another name for recyclables. At the recycling facility, the two wastes are processed separately. In some cases the wet material is inspected for contaminants such as recyclables or hazardous waste. Upon passing inspection, the trash is ground into fine pieces. It is then placed in a commercial composter. This can be a vessel where the conditions needed for composting are simulated over an accelerated time frame. In a matter of weeks, an end product, ready for use, can be recovered.

The other way to process wet trash is to let it compost naturally. Some facilities keep the wet material indoors while it is composting; others place it outdoors. Periodically, the piles are turned to assist the process. Eventually, the material breaks down and is screened. Contaminants and pieces too large to compost are removed. The pit fall of not removing the unwanted items before composting is, the finished



Markets (cont.)

the plastic wood is damaged or made useless, it becomes garbage. Open loop is not necessarily a bad way of handling waste. Some material cannot be recycled in a closed loop system due to the lack of available technology or other factors. Under such circumstances, recycling material once is better than not recycling it at all.

Further proof of the existence of markets can be seen in the goods made from recycled products. The demand for these goods urges business and industry to buy recyclable material. This leads to the creation of markets. Examples of recycled products and the re-manufacturing methods used to make them are listed below.

Paper (See HANDOUT: **Paper Process Flow Chart** D53)

The use of paper in recycling depends upon the grade of the material. These grades are determined by fibre length; the longer the fibre, the higher the grade. A general ranking of paper, from highest to lowest, is as follows: fine paper, newspaper, box board and kraft paper, cardboard and lastly paper towels and toilet paper. Most paper is recycled in the same fashion. Upon arrival at the plant, the material is churned in a *pulper* with special soaps, then passed through a series of filters and screens to remove contaminants. The mixture now enters flotation cells where air bubbles take inks, soaps and clay fillers to the surface. These are skimmed off and in some cases, the ink is collected for recycling. De-inked pulp is now mixed with new pulp from virgin resources. After passing through presses, dryers and rollers, sheets of recycled paper are produced.

The need for virgin paper would seem to defeat the purpose of recycling but this is not the case. Re-manufacturing paper causes the fibres to become shorter, thereby down-grading the material. Adding new pulp helps keep the old paper strong enough to be useful. Some paper, like newspaper, can be made of 100% recycled product.

Typically, the different grades of paper are either made into a new version of the same product (e.g. fine paper to fine paper) or mixed to make other items. An example of the last point would be using telephone directories to make paper towels. Sometimes material is mixed with non-paper products to form new goods. Old newspaper is combined with fire retardant material to make insulation. Cereal boxes, fine paper, cardboard boxes, books and magazines are also made from recycled paper.

Glass (See HANDOUT: **Glass Process Flow Chart** D54)

Glass is the second greatest recycled material by volume in Canada. Colour is used to differentiate one type of glass from another. Generally, the division is decided by whether the glass is clear or coloured. In some cases, the latter may split into two more categories: green and brown. To tell which class *frosted glass* falls under, a person should examine the neck of the container. Other bottles appear to be clear, but are really a very faint green or blue. By holding this type of glass to the light, the colour can be identified.

Recycling operators collect, sort by colour (depending upon the buyer's request) then ship old glass to facilities where new containers are produced. These loads are inspected by the glass manufacturers to ensure the material is acceptable. Recycled clear glass used to make new clear glass must be 99.5% pure. Conversely, up to half of the waste glass used in making green bottles can be different in colour. Clear and

Markets (cont.)

coloured glass is stored, processed and re-manufactured separately.

The first step in re-manufacturing is to grind the glass into small pieces called cullet. Magnets and air are used in a process called beneficiation, to remove metal, paper and other contaminants. From here the clean cullet is sent to the furnace where it is mixed with sand, limestone and soda ash used in the making of new glass. For clear glass 20% to 30% cullet is added to the virgin material. If sufficient quantities of cullet could be found, clear glass could be made from 100% recycled material. Green bottles can be made from nearly 70% coloured cullet. Upon exiting the furnace, new glass is mechanically shaped and finished into an array of bottles and jars.

Some glass by-passes the obvious avenue of becoming the same product. Fibre glass and reflective paint can both be derived from old containers. Glass can act as a substitute for a portion of the aggregate used in asphalt. Three million bottles could be used in paving a single lane more than one metre deep, for a distance of one kilometre. Recycled glass is also used in the making of *geotextiles,* which become items such as sewer pipes. Ground glass is useful as an abrasive in sandblasting processes, too. Coloured glass has been added to stucco allowing the wall covering to be applied in a variety of hues.

Metals (See HANDOUT: **Metal Process Flow Chart** D55)

The generic name for waste metals is scrap. Scrap can be generated at the mill or foundry (home scrap), during the manufacturing of metal products (industrial scrap) or from worn and discarded good (obsolete scrap). In the context of recycling we will divide scrap metal into four classes: tin, steel, aluminium and other metals.

Most people associate the word tin with food cans. However, a "tin can" is actually made of steel and has a very thin protective coating of tin or other food-safe material. Removing this coating starts with the cans being washed in a strong *caustic soda* solution. The tin and unwanted contaminants are dissolved. The steel cans are removed, quadruple rinsed, then compressed into 230 kg bales. A conveyor delivers the bales to rail cars, bound for steel mills.

Meanwhile, the detinning solution is constantly filtered to remove tin crystals and other impurities. The tin crystals are re-dissolved in water and then sent to a purification stage where grease, heavy metals, organic material or other unwanted items are removed. The purified solution is now sent to one of two processes.

In the tin electrowinning process, negatively charged chains (cathodes) are lowered into the solution. As the electric current passes through the solution the tin is attracted by and adheres to the chains. The cathodes are then removed and dipped in a vat of molten tin where, because of the different melting points, the recovered tin dissolves but the chains remain intact. The metal is then formed into 30 kg ingots.

For the tin chemical process, the solution is neutralized to produce a tin oxide powder. This powder is water washed to remove impurities and then chemically converted to either potassium or sodium stannate, which are used to plate tin onto automobile and electrical equipment and the Canadian dollar coin.

Markets (cont.)

Recycling scrap steel to make new steel has been practised for a long time. Half of the resources used in the steel making process is scrap. The major change has been in the source of the recyclable material.

Traditionally, 50% of the scrap used was home scrap, generated in the mills themselves. Improvements in steel making technology have cut this percentage nearly in half. To compensate for this reduction, increasing amounts of used steel is purchased from outside sources. The majority of this metal is post consumer; items that have been bought, used and recycled. To illustrate the importance of post consumer steel consider this: if all the steel produced was made into cans, one-fifth of these containers would be made from steel that the public has diverted.

Scrap steel is first deposited into a furnace for melting. Electric, basic oxygen, open hearth and blast furnaces are all used to liquefy the steel: the type of furnace used depends upon the finished product desired. Scrap placed in an electric or basic oxygen furnace can produce carbon steel. When added to a blast furnace, recycled steel replaces a portion of the iron ore used to make pig iron. Regardless of the type of furnace, after heating, the molten metal is sent for processing. Again the method and extent of processing is directly related to the end product required. Upon completing the processing stage, the new steel is ready for market.

Recycled steel can become anything from raw materials for more steel (pig iron) to ready-to-use articles such as "I" beams, steel sheets, tin cans and automobiles.

Originally, aluminium was prized for its strength, light weight and ability to resist corrosion. Today, it is seen as a chance to save vast amounts of energy. How, you might ask? Aluminium is produced from an element called *bauxite*. Facilities that convert the element into the metal demand so much power, that some plants require their own hydro-electric generating system. This is not where the energy saving occurs. The savings come when existing aluminium is used as a raw material.

Scrap aluminium is divided into two groups: new scrap and old scrap. New scrap is generated by fabricators making consumer or industrial products. It includes trimmings, chips, and turnings from machine operations and residue such as *dross*. Old scrap is post consumer products.

Recycling aluminium uses just 5% of the energy needed to make the metal from virgin resources. This is a 95% reduction in energy usage. The energy saved by recycling the aluminium gathered through Ontario's Blue Box program could power 70,000 television sets continuously for one year.

After being separated from steel and other metals, aluminium products are shredded, delaquered and melted down. Some facilities take the dross produced in the furnaces and recycle it as well. Removing the aluminium in dross can raise *metal recovery* from 75% to 96%. Like steel, the final use of the aluminium dictates to what extent it is further pressed. It can be sold in liquid form, made into ingots ranging in size from 16 kg to a tonne or poured into moulds to make finished products. Engine blocks, valve covers, wheels and beverage containers are made from recycled aluminium.

Most other metals are not found in sufficient quantities to be collected from individual homes. However, business and industry may produce enough scrap copper or iron, for example, to justify recycling.

Markets (cont.)

Scrap metal dealers, not recycling companies, usually collect these materials. The two basic methods of recovering metals are: remelt applications or chemical processing. Remelt techniques are used to retrieve iron. Copper is recovered chemically, in much the same manner as tin.

Plastics (See HANDOUT: **Plastic Process Flow Chart** D56)

Like paper, plastics come in many different forms. The resins used in making the plastic, distinguish one type from another, but most of the material is processed in the same manner.

At a recycling facility, empty plastic products are normally separated and inspected. Some operations leave the resins mixed, while others remove specific plastics. Although these processes can be automated, people are generally used to correct mistakes made by the machines.

It is difficult to remove contaminants due to the small openings found on many plastic products. By shredding the plastic first, the recyclable material is easier to wash. Further separation can occur during the cleaning stage. Lighter resins can be removed as they float near the surface of the washing solution. Clean plastic flakes are dried then ground finer. Finally, the plastic is extruded into new products or into pellets.

Recycled plastic becomes insulation for coats, sleeping bags and similar applications. Some oil jugs are made from re-manufactured High Density Polyethylene (H.D.P.E). Bleach bottles, brush bristles, carpet backing, rope, trays and automobile bumpers all can be made from recycled plastic. Used food and beverage containers are not converted to new versions of the same product because minute traces of contaminants may be persistent in recycled plastic. For safety reasons, the plastic used to hold what we drink and eat is always new.

Like so many other myths, the one claiming there are no markets for recyclable materials has been blown out of proportion. Myths are normally based on some truth but as the story is repeated, the tale becomes more and more extravagant. The truth about markets is; they are available.

Symbols

Figure D-5

It is difficult to purchase an item that does not claim the product or packaging is recycled or recyclable. At first, the words and symbols used to convey these notions would seem to be a blessing, helping the consumer to make environmentally sound purchasing decisions. In reality, the text and graphics can lead the public astray. The following information is targeted at helping the consumer make the correct choice.

The most famous of all symbols is shown in Figure D-5. Called a *Mobius loop*, this three sided graphic is synonymous with recycling. A 19th century German mathematician named August Mobius, first made this loop by taking a strip of paper, twisting it once and joining the ends. It was meant to be a toy for children; the amusement being the loop has one continuous side. Recycling is a never ending process, so Mr. Mobius' figure was an appropriate symbol. The three arrows were added to represent the stages of recycling. The American Paper Institute, who holds the U.S. rights to the three sided loop, defines the stages as follows: the first is the collection of recyclable materials, then comes the production of new recycled products and packaging, and lastly, is consumer recognition of the role recycling plays in society.

At present, there are no Canadian regulations, either at the provincial or federal level, governing the use of the Mobius loop. Some businesses use this symbol and the term recyclable, to lure environmentally conscious consumers into buying products. In theory, almost anything can be recycled, but objects are only truly recyclable where facilities, technology and markets to handle the items exist. Not enough people realize this last point. Regardless of what you buy, if the recycling company in your area does not take the item, it is not recyclable.

Mobius' little triangle is not used solely as a sales pitch. When the loop encloses a number, it becomes part of the *Plastic Container Code System* for plastic bottles. The symbol and number are usually accompanied by several letters, providing an easy method of verifying if a container can be recycled. If you have a list of what can and cannot be recycled in your area, look at the symbols on your recyclables to see what is acceptable. In areas where no such list is provided, telephone the company emptying your Blue Box or depot and ask which numbered containers are accepted. The symbols and letters are explained in Figure D-6.

Figure D-6

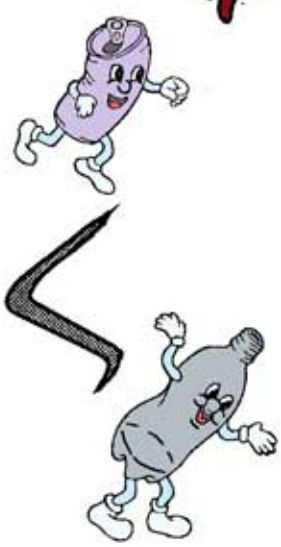
A black and white loop illustrates *recycled content,* expressed as a percentage by weight of the product or total material. Normally accompanying the graphic and numerical figure is a caption

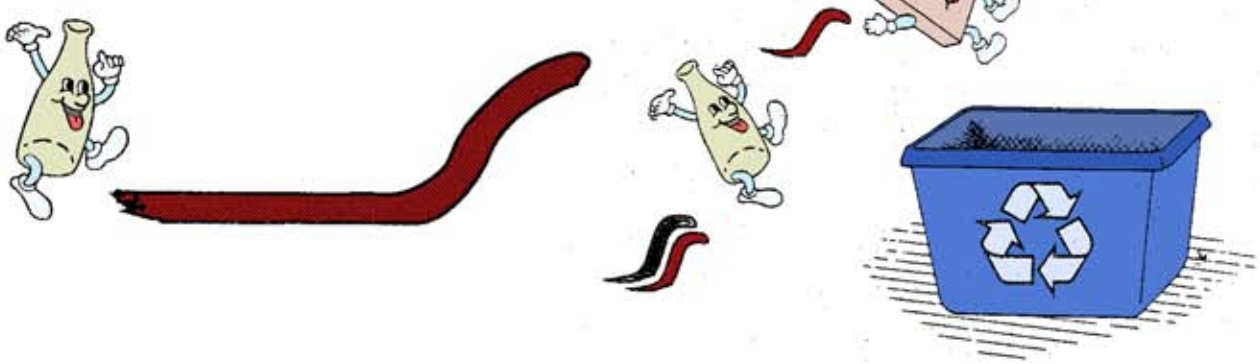
Brewster Facts

1. Recycling is the third "R".

2. Recycling is easy to do. By putting the right things in a Blue Box or depot you can recycle.

3. Recycling turns old things into new things. This saves natural resources. Recycling is good for the Earth.





Loop de Loop

OBJECTIVE: To introduce recycling symbols to children.

MATERIALS: glue, paper, pen or pencil, HANDOUTS: **The Twister** (D25), **Twisting Arrows** (D26), **Arrow Cut-Outs** (D27)

VOCABULARY: consumers, Mobius loop, recycling, remanufactured, symbol

BACKGROUND:

Recycling is in theory a never ending process. Steel, aluminium, paper and other recyclable materials are remanufactured repeatedly. Because of its continuous nature, recycling requires a special symbol.

In the 19th Century a German mathematician named August Mobius made a loop by taking a strip of paper, twisting it once and joining the strip's ends. The strip was meant to be a toy for children but today it is the symbol for recycling. By twisting the piece of paper Mobius created a loop with one continuous side that has no start and no finish just like recycling itself. By adding three arrows, the loop represents the three stages of recycling: separation and collection of materials, manufacturing of recycling products, and consumers buying recycled products.

PROCEDURE:

1. In front of the class take a strip of paper, twist it once and attach the ends of the paper together. Explain to the children that the loop you have made has one continuous side; there is no end or beginning to the loop.

2. Have the children make their own loops. Distribute the HANDOUT: **The Twister** (D25) to the class. Ask them to take a pen, pencil, etc. and draw a line on the loop. The line should appear on both sides of the loop, before arriving back where the line began, if it is drawn properly.

3. Tell the class the story of August Mobius, the inventor of the loop.

4. Now hold up a picture of the recycling symbol to the class. Ask the students what the symbol means.

5. Explain the symbol stands for recycling and it too is a Mobius loop. Mention to the class how recycling is a never ending process where things are placed in the Blue Box, recycled, sold and then placed in the Blue Box over and over. Because the Mobius loop has no end it is a good symbol for recycling.

6. Tell the class the arrows were added to the loop to show how recycling "goes around and around".

Loop de Loop (cont.)

PROCEDURE (cont.)

7. Use the HANDOUT: **Twisting Arrows** (D26) to show the children how they will make their own Mobius Loop. Photocopy the HANDOUT: **Arrow Cut-Outs** (D27) and distribute a copy to each child. If possible, copy the HANDOUT as it appears (printed on both sides). This will make a better finished recycling symbol.

8. After cutting out the arrows the children tape them point to tail (see Step 1 on D26) to make a strip. The strip is then twisted once before closing into a loop (Step 2). Finally, the children fold the arrows flat (Step3).

9. Finish the activity by telling the class to watch for the recycling symbol on things they buy, use or throw away.

EXTENSION:

1. Have the class draw or paint a picture about recycling. Place the drawing or pictures on a bulletin board using the children's recycling symbols as a border.

2. Use the students recycling symbols as the foundation for posters.

3. Award different coloured (silver, gold, green) symbols to students who are "good recyclers".

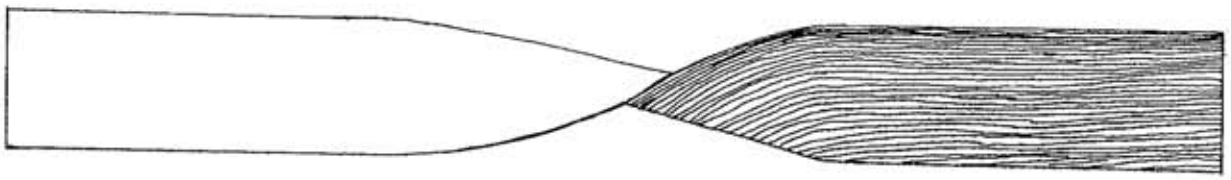
EVALUATION:

1. Ask the class why a Mobius loop is a good symbol for recycling.

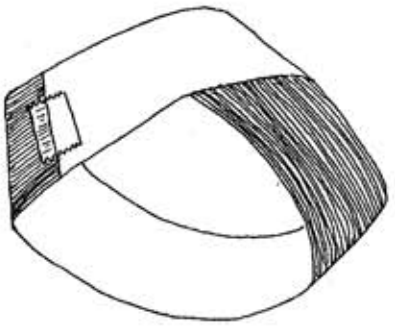
2. Will the students begin to look for the recycling symbol at home and in school?

3. Did the students have the skills necessary to construct a Mobius loop?

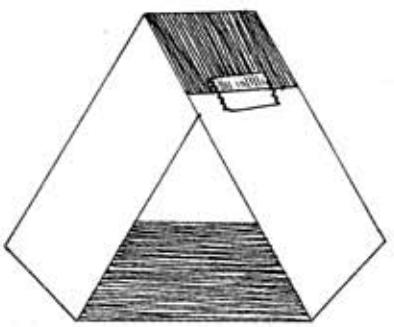
The Twister



Cut out a strip of paper approximately 25-30 cm long and 2.5 cm wide. To make it easier to tell one side from the other, colour in one side of the strip.



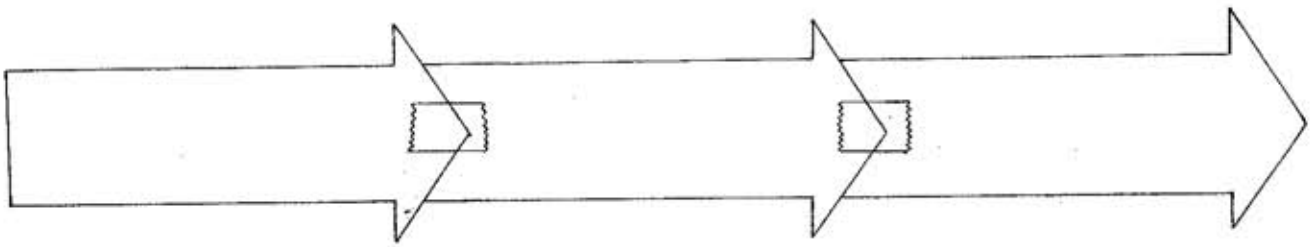
Holding the strip directly in front of you make one complete upward twist with the end in the right hand. Fasten the two ends with tape. (one coloured side and one plain side should be showing when taped)



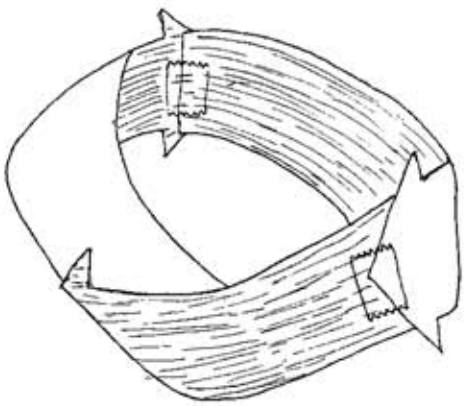
After it has been securely fastened, proceed to flatten the loop so that it resembles the above diagram. You now have a Mobius loop.

Twisting Arrows

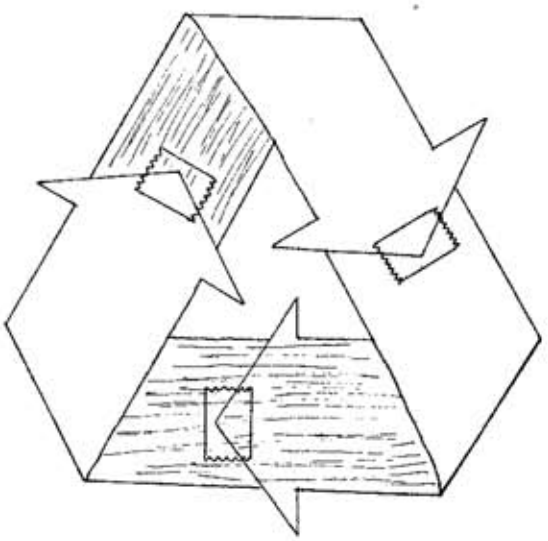
The recycling symbol commonly seen is the Mobius Loop with three arrows pointing in a clockwise direction. You can make one of these by cutting out the arrows on the next page (D27-D28) taping them together end to end, twisting once, looping and flattening. You could also just cut out the arrows and glue them in the proper form on a separate piece of paper.



Step 1

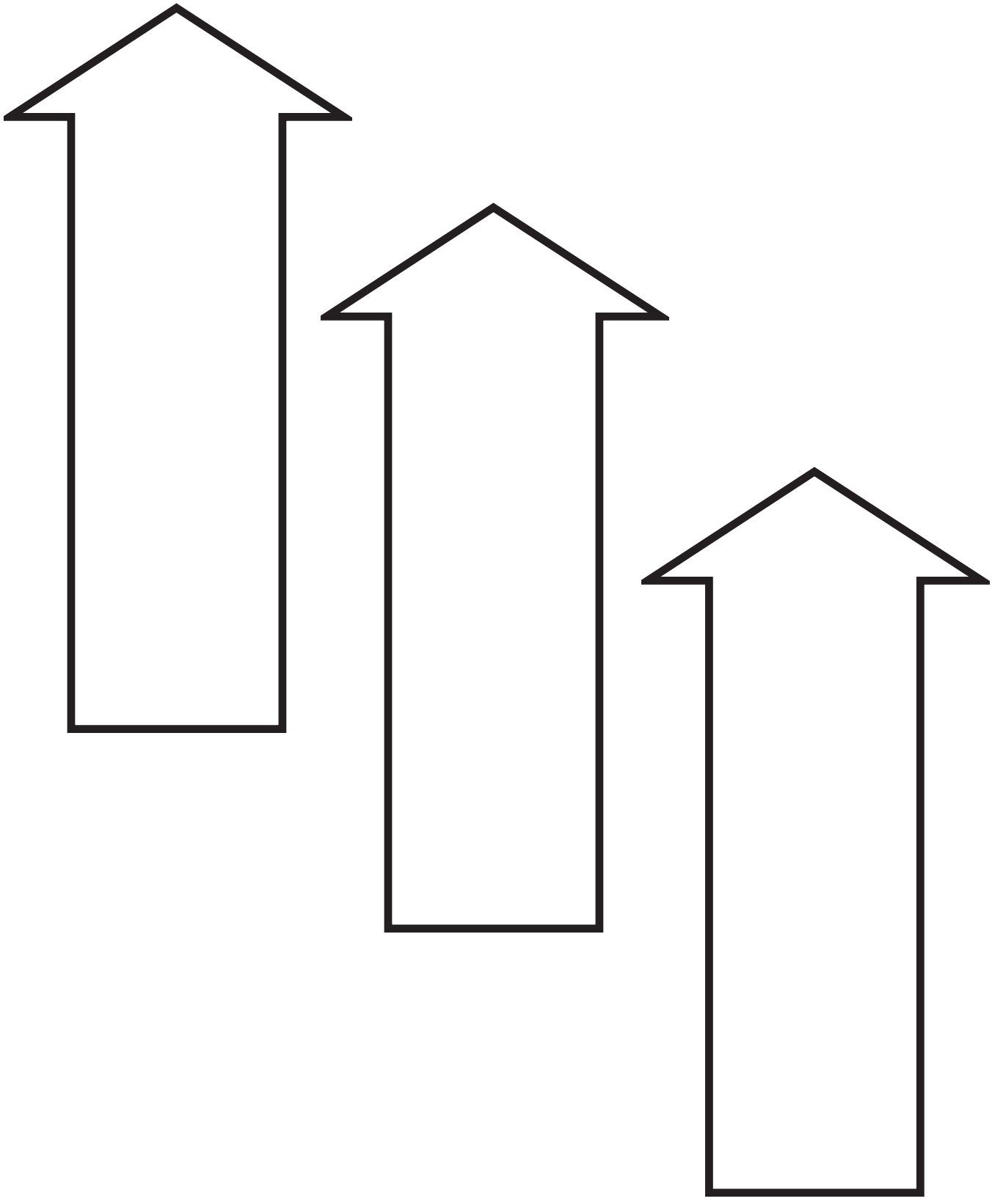


Step 2

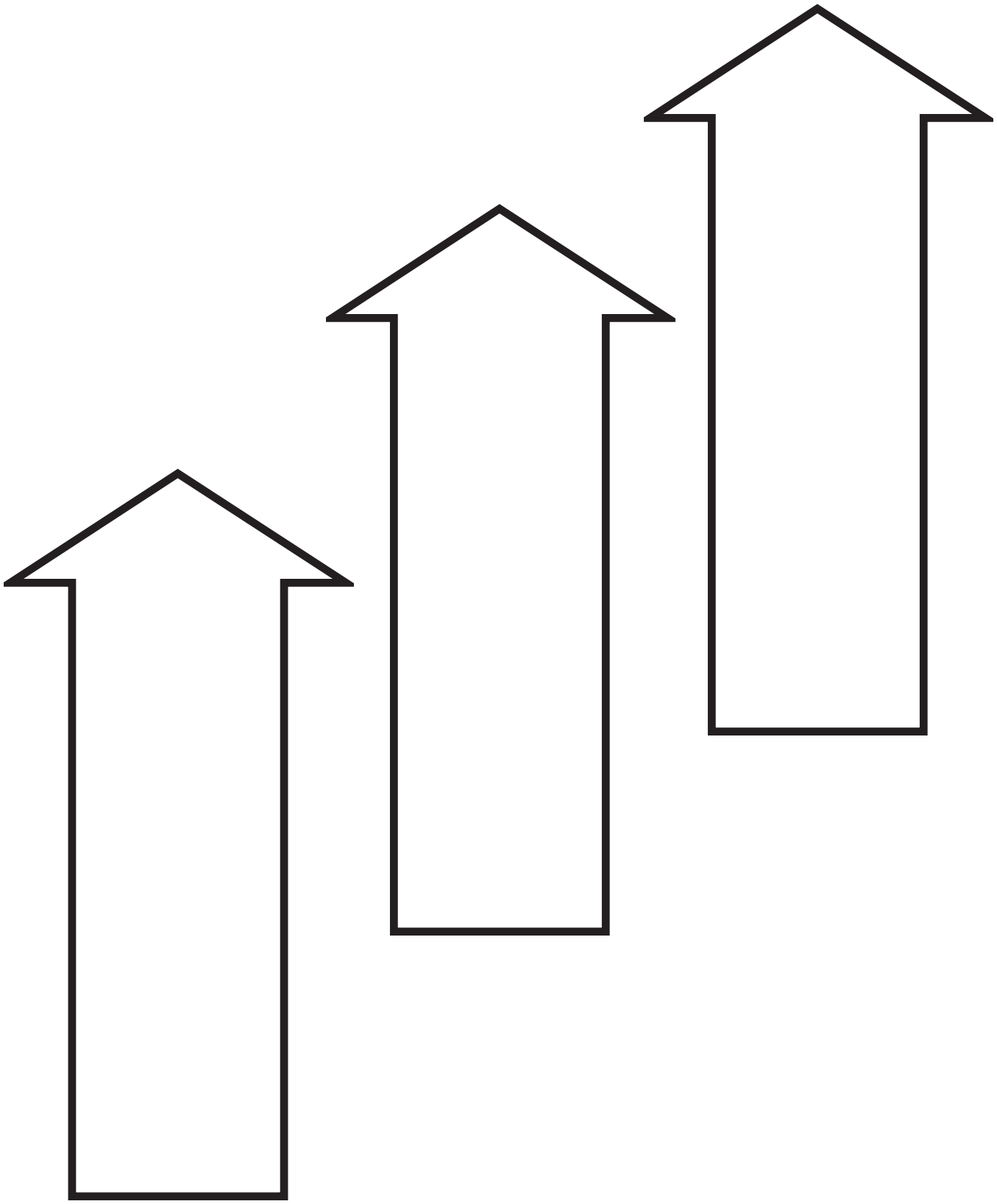


Step 3

Arrow Cut-Outs



Arrow Cut-Outs (cont.)



"Lingo" Lesson

OBJECTIVE: To make children familiar with recycling terminology.

MATERIALS: pencil, HANDOUT: **Recycling Words** (D31-D32)

VOCABULARY: Blue Box, environment, recycle, waste management

BACKGROUND:

The words recycle, Blue Box and environment are household names. This activity allows the children to become familiar with other recycling and waste management terms.

PROCEDURE:

1. Give each child a photocopy of the HANDOUT: **Recycling Words** (D31-32). Go through the list of words and briefly explain each term to the class.

2. Now have the class find the words hidden in the puzzle.

EXTENSION:

1. Hold a contest to see which student can find the most words in the puzzle. After a set period of time stop the class then read the list of words the puzzle contains.

2. Design other puzzles using recycling terminology; fill in the blanks and crosswords are two suggestions.

3. Ask each child to draw or paint a picture that illustrates their favourite word.

EVALUATION:

1. Ask each child to print three words from the list.

2. Ask each child to repeat his or her favourite word from the list and explain what it means.

3. Ask the class if they think recycling is a good idea.

Personal Notes

Recycling Words

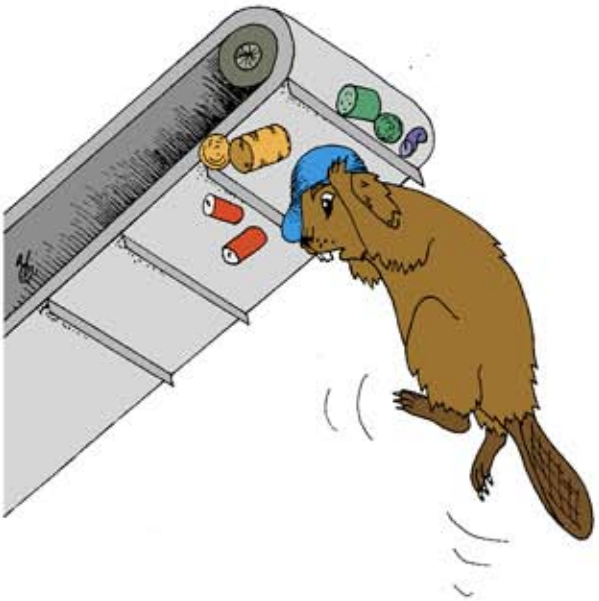
A E S P L M V S T X W A M F R H G
N R B O X B O A R D G J L E B T U B
E B L L C L D M O B I U S L O O P Z R
W F U L G U H J K M N P Q R T S A T X H
S Y E U R E C Y C L E X Z B H E P L S A M
P W B T Z B D S D F U P E N W B S
A F A I G O H M Q G A R B A G E
P J G O K X L T L N H R G F T D N
E M P N Q R S B C D F G X W D A J K E L
R E C Y C L I N G T R U C K I T L N R
E N V I R O N M E N T B C D R E F C
F G T H J K N L P M P L A S T I C
B R E W S T E R W B E A V E R Q
S P L A N E T X B N Z C A W D
Z M E T A L Q A D G L T F B
D E P O S I T S W J A R U A M
M T H S R L Z K L C N Q T D R
A D O F C G A B X D A U E S
G L N M A R B N E F C R P M B
A S E A R T H C S I D E O N T
Z D B L D N C A L I T T E R
I H O J B K L G L A S S B F R
N P O S O T U Y I N Y L Q X W
E V K W A X Y F R M A G N E T
Z G M T R E E E C B O T T L E
P A C F D K N N F O R E S T X
B D X W Q R S A B L D F S R Z

Recycling Words (cont.)

BREWSTER W. BEAVER	TELEPHONE BOOK	HUGHDIR T. RAT	RECYCLING TRUCK
BLUEBOX	GLASS	NEWSPAPER	LITTER
SYMBOL	PLASTIC	EARTH	PLANET
MOBIUS LOOP	METAL	DEPOTS	WATER
GARBAGE	DEPOSIT	BLUEBAG	LANDFILL
JAR	CARDBOARD	TREE	ENVIRONMENT
PAPER	BOXBOARD	POLLUTION	FOREST
FUTURE	LAND	BOTTLE	MAGAZINE
MAGNET	LIFE	SEPARATE	RECYCLE

All words are across or down.
No words are backwards.

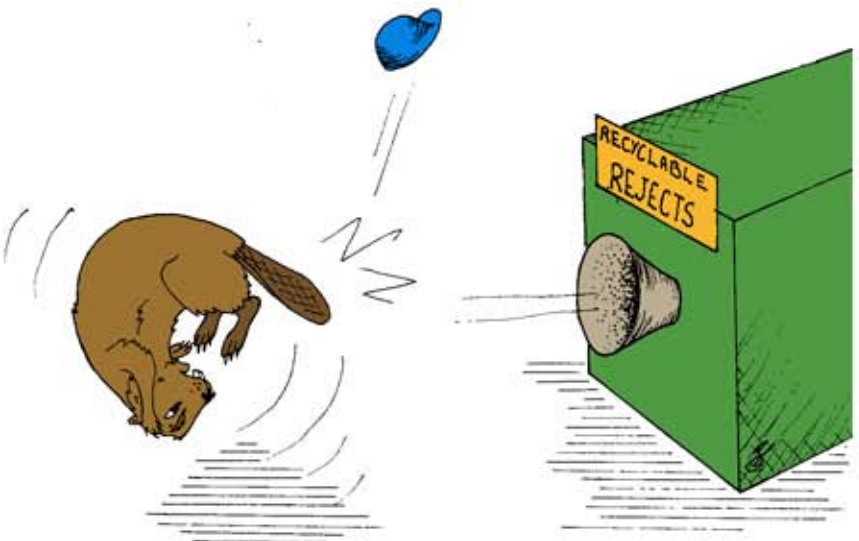
Brewster Facts



1. Recycling is the most famous of the "3 R's". In Ontario, nearly 80% of all households recycle using a Blue Box.

2. Recycling is the separation of items for use as raw materials to make new things. Recycling should be a closed loop or circle. At home take recyclables from the garbage and put them into the Blue Box or Depot for collection. These items are sorted and sold to companies who make them into new products. These are sent to stores for you to buy. This makes a full circle or closed loop.

3. The amount of natural resources on Earth is limited. Both renewable and non-renewable resources need to be treated carefully. Recycling allows the resources we have already used to be used over and over.



4. By recycling, a person can make one-third less garbage. Call your recycling company to see what products they accept. Then only buy items that you can recycle.

Recycle, My Hero

OBJECTIVE: To show how values influence peers.

MATERIALS: craft materials, HANDOUT: **Wanted: Superhero** (D37)

VOCABULARY: Blue Box, environment, peer pressure, recycling

BACKGROUND:

Peer pressure is a double edged sword. It can push individuals to excel or cause them great harm. Friends can influence a person to smoke or choose not to smoke, steal or not steal and so on.

Positive peer pressure was instrumental in spreading recycling across the province. Because more and more communities were doing something good for the environment other communities did not want to be left out. Today four out of five homes have a Blue Box to place at the curb for collection. This activity will illustrate how positive peer pressure can make a difference.

PROCEDURE:

1. Explain the concept of peer pressure to the class. Be sure to provide both positive and negative examples of peer pressure. Mention how friends can affect the way a person thinks, feels, dresses or talks. They can also influence the television shows a person watches, the music they listen to and many other things.

2. Ask the class to think of examples of peer pressure (i.e. smoking, studying, etc.).

3. Tell the class they are going to use a cartoon character to put positive peer pressure on their friends, families and schoolmates to help promote recycling. You could photocopy HANDOUT: **Wanted: Superhero** (D37) or use as an overhead to stimulate thinking.

4. Each child is to design a "recycling superhero". The hero can be a male or female person, an animal or an inanimate object. The only limitation is the super hero must be designed to promote recycling. The superhero could be completed over several Art periods.

5. After the designs have been completed each student presents their superhero to the class. Students should explain what aspects of the superhero would influence people to recycle.

Recycle, My Hero (cont.)

EXTENSION:

1. Feature a different superhero in the classroom each week. Beside the hero place the Blue Box or recycling containers.

2. Make names for the superheroes.

3. Create mottos for the superheroes.

EVALUATION:

1. Have the children explain why they chose their superhero to represent recycling.

2. Do the children think their superheroes will encourage others to recycle?

3. Explain what it means to recycle.

Wanted: Superhero

"This job is big enough for two.
Create a partner to help me
convert ignorant garbage
producers!"

Signs Of The Time

OBJECTIVE: To provide a better understanding of recycling and waste management symbols.

MATERIALS: packaging with environmental symbols, pencil or pen, HANDOUTS: **Status Symbols** (D42), **Today's Status Symbols** (D41)

VOCABULARY: Blue Box, depot, earth friendly, green, non-recyclable, legislation, packaging, recycling, symbol

BACKGROUND:

Despite being easy to do, recycling can be confusing. The three-arrowed recycling symbol is at the centre of this confusion. Because there is no legislation for recycling symbols they appear everywhere. Besides the three-arrowed symbol, there is a symbol comprised of a black circle enclosing three arrows and another with the arrows encircling a number. Each of these symbols has a different meaning, yet most people see three arrows on a product and assume the product is recyclable; this assumption is wrong. Misunderstanding symbols is the major cause of non-recyclable items being placed in Blue Boxes or depots. When items that have the three arrows on them, in any form, are rejected by a recycling company, people become confused. By understanding what certain symbols really mean confusion can be avoided.

PROCEDURE:

Before starting this activity you should be familiar with the Symbols section (D19-D20) of the Recycle chapter. The most commonly found symbols are illustrated and explained in this section.

1. Ask the children to bring three or four products or pieces of packaging to school. The products/packaging must exhibit recycling symbols or claim to be recycled, recyclable, earth friendly or green.

2. Divide the class into groups. Each group is to copy, onto a piece of paper, the words or symbols found on their products.

3. Give the students the HANDOUT: **Today's Status Symbols** (D41) or use it as an overhead. Now give each group the chart on the HANDOUT: **Status Symbols Chart** (D42) to complete. You may have to contact your recycler to get some of the information required for the chart.

EXTENSION:

1. Have the class think of better ways to use symbols. For example, legislation stating where a symbol must appear.

2. Make a display for the school's recycling centre explaining recycling or waste management symbols and words.

Signs Of The Time (cont.)

EXTENSION (cont.)

3. Have a contest to design a T-Shirt that promotes recycling. The symbols and words the class have discovered could be used in the designs.

EVALUATION:

1. Will the children take time to check for symbols on the articles they purchase in the future?

2. Ask each child to explain one symbol or word found on one of their products.

3. Have each student write an essay expressing their opinion of symbols.

Today's Status Symbols

The Mobius Loop is the most famous recycling symbol. The three arrows give the impression of something happening over and over again. Recycling is supposed to be a never ending process so the Mobius Loop is a good symbol to show this. However there are no laws controlling the use of the loop. Some businesses use the symbol on things that cannot be recycled.

When three arrows are used to form a triangle around a number, this is part of the Plastic Container Code System. Plastic containers are made from different types of plastics. Each type of plastic is given a number between 1 and 7. This System is a guide to help people and recycling companies separate plastics.

A Mobius Loop in a black circle shows recycled content. This is given as a percentage of the product or total material. Sometimes the words post consumer are also beside the loop and circle. This means the raw material used to make the item has been bought before, used, and recycled.

Ecologo is the symbol used by Environment Canada in its Environmental Choice[M] program. This helps Canadians find products and services that are less harmful to the environment. Only products and services that pass the program's standards are licensed to use the name or logo.

RECYCLE - JUNIOR HANDOUT

Status Symbols Chart

SYMBOL & MEANING	WHAT DOES IT MEAN & WHAT WAS IT ON?		PACKAGING: Recyclable? Yes or No	PACKAGING: Made from Recycled Materials Yes or No	PACKAGING: Made from Recycled Materials %	PRODUCT: Recyclable? Yes or No	PRODUCT: Made from Recycled Materials Yes or No	PRODUCT: Made from Recycled Materials %	HOW COULD PACKAGING/PRODUCT BE IMPROVED ENVIRONMENTALLY?

Bluewater Recycling Association - Sept/93

Brewster Facts

1. Recycling is the most famous type of waste management. In Ontario the words "Blue Box" have become part of everyday life. About 80% of Ontario homes recycle with a Blue Box system.

2. On average everyone in Canada produces one tonne of waste each year. Recycling can divert close to 30% of our waste from landfills. In a year, recycling could divert nearly 10 million tonnes of waste in this country.

3. Recycling begins when a person separates recyclable items from other waste at home, school, or work; this is called source separation. They are then collected and sorted by a recycling company. The amount of sorting depends upon needs of the company buying the products. Recyclable materials are then used as raw materials in manufacturing new items. When you buy them the recycling loop starts all over again

4. It is important for people to buy recycled products. Companies only make things they think will sell. When a person buys a pad of recycled paper for example, this lets the company who makes the paper know there is a demand for the product. They buy their raw materials to make new paper from recycling companies. Recycling companies get their paper from the Blue Boxes or depots that you fill. Buying recycled products completes the recycling loop.

5. There are many recycling symbols. Most have three arrows bent to form a triangle. The triangle is based on a Mobius Loop; the loop is named after its inventor August Mobius. There are no laws regulating the use of recycling symbols or the words recycled and recyclable. People should call their recycling company before placing recyclable material in the Blue Box or depot. If the recycling company does not collect a certain type of container or other product then that container or product is not recyclable no matter how many recycling symbols it has.

6. Recycling is a great method of saving our natural resources and energy. Making an aluminium can from recycled aluminium uses just 5% of the energy needed to make the can from raw bauxite. Remember recycling is smart so do your part!

Down & Across

OBJECTIVE: To provide students with an understanding of recycling and waste management terminology.

MATERIALS: pencil, HANDOUTS: **Crossword Clues** (D48) and **Crossword Quest** (D47), HANDOUT ANSWERS: **Correct Crossword** (D49)

VOCABULARY: abbreviations, acronym, communication, environment, recycling, terminology, waste management

BACKGROUND:

Understanding a concept is easier when a person understands the concept's key terms. There are many words special to waste management and recycling. This activity will expose students to terms, acronyms and abbreviations special to these topics.

PROCEDURE:

1. Explain to the students how important it is to understand special terms when studying in a new field. Give examples such as the medical profession or automotive maintenance where communication depends upon people knowing the proper terminology.

2. Distribute copies of the HANDOUTS: **Crossword Clues** (D48) and **Crossword Quest** (D47) to the students.

3. Using the Glossary (D59-D62) discuss the meaning of each word on the HANDOUT (D48) with the class. Now give the class time to complete the puzzle.

EXTENSION:

1. Have the students design their own crossword puzzles. These could be made for the primary or junior grades.

2. Hold a "scrabble" contest. Students are only allowed to use words related to the environment or waste management.

3. Keep a "dictionary" of waste management terms the class learns over the course of the year. Each week a different student is responsible for finding a new word and its definition to add to the list.

Down & Across (cont.)

EVALUATION:

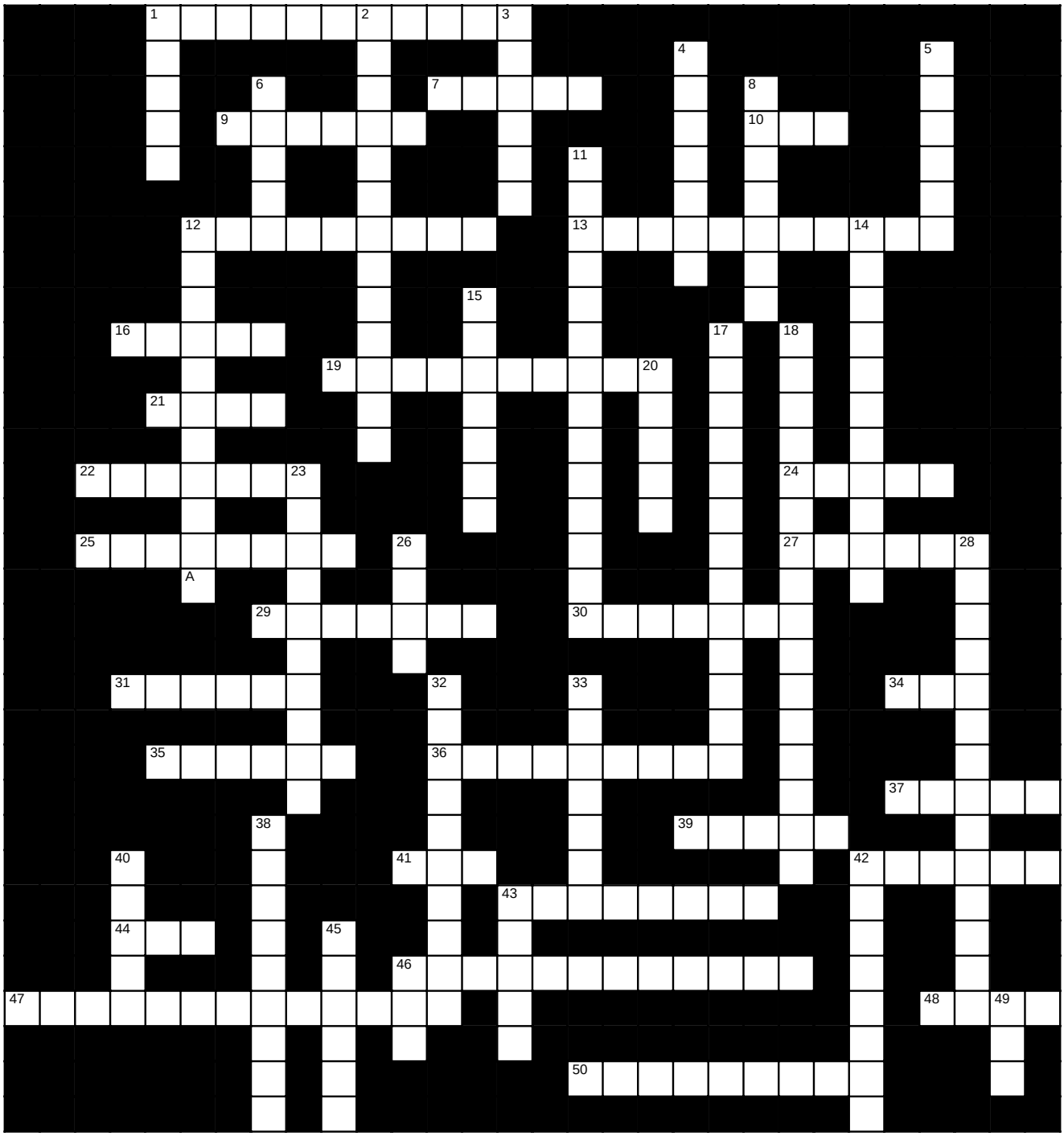
1. Ask the students to name other areas where good communications and clearly understood terminology would be important (Note: this is a tricky question. All fields require good communications).

2. Will the students take time to look for words, they do not understand, in the dictionary.

3. Did the crossword clues improve the students' problem solving skills?

RECYCLE - INTERMEDIATE HANDOUT

Crossword Quest



RECYCLE - INTERMEDIATE HANDOUT

Crossword Clues

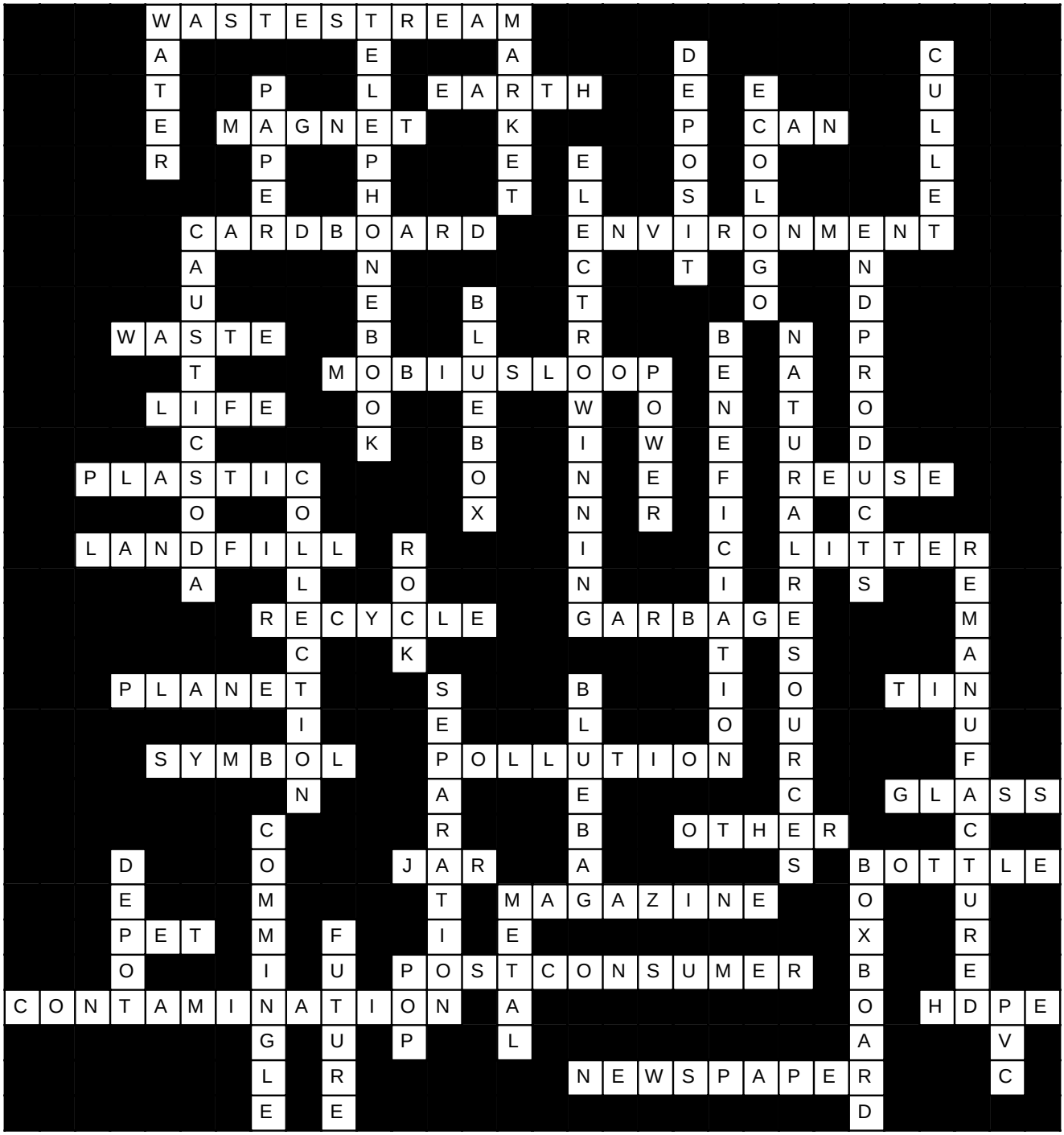
ACROSS

1. waste material output or a household area.
7. our planet
9. steel sticks to it
10. kick the ___
12. very thick paper used to make boxes
13. the air, water and earth around us combined
16. _____ not, want not
19. continuous ended figure that has become a famous symbol
21. opposite of death
22. petroleum product
24. use over again
25. hole in the ground used to hold waste
27. waste thrown on the ground
29. to cycle again
30. waste that has no use
31. Saturn is the name of a _____
34. Dorothy, Totto, the Lion, the Scarecrow and the ___ man
35. a graphic or letters that stand for or represent something
36. substances in our environment that dirty it and are harmful
37. breakable material
39. do you want this one or the _____ one.
41. glass container
42. glass pop container
43. Young & Modern or Teen _____
44. acronym for Polyethylene Terephalate
46. adjective for products that have been bought and used
47. the presence of unwanted material
48. acronym for High Density Polyethylene
50. paper that tells all the latest news

DOWN

1. H_2O
2. a book you look phone numbers up in
3. place where you buy, trade and sell
4. money refunded when a pop bottle is returned
5. glass that has been intentionally crushed prior to being mixed with other raw materials
6. pulp is turned into this
8. environment Canada approved symbol
11. process to remove tin from steel
12. _____ ____ is used to clean recyclables
14. recycled materials are remanufactured into this
15. plastic container to put recyclable items in
17. process through which contamination is extracted from glass cullet
18. timber, water, minerals, fossil fuel and any other naturally occurring resources that could be used by humans
20. solar p___
23. an organized pick up
26. ____ and Roll
28. manufacture again
32. the act of dividing into separate categories
33. blue container, not a box, used to collect recyclable items
38. recyclable materials that have been separated from other garbage but not from one another; still mixed together
40. drop off spot
42. recyclable used to make cereal boxes
43. Heavy _____
45. opposite of the past
46. soda __

Correct Crossword



Personal Notes

Recycle Research

OBJECTIVE: To show how recyclable materials are remanufactured into recycled products.

MATERIALS: recyclable item, research materials, HANDOUTS: **Flow Charts** (D53-D56)

VOCABULARY: Blue Box, collection, depot, diagram, facility, flow charts, graphics, manufacturers, raw materials, recycled, separation

BACKGROUND:

Most people do not know what happens to the contents of their Blue Box or depot cart after it has been collected; generally, all people really know is the contents "get recycled".

As people gain a better understanding of how old materials are converted into new products, the entire recycling process, including separation and collection, becomes clear.

PROCEDURE:

1. Ask the class if anyone knows what happens to recyclable items after they are collected. Field a few comments from the students, then explain the following:

    - after being collected recyclables are separated.

    - the separation depends upon what the material is (glass, paper, etc.) and what it is being recycled into.

    - separated materials are used as raw materials by manufacturers.

    - the end products made by the manufacturers are sold as recycled items.

2. Use the HANDOUTS: **Flow Charts** (D53-D56) to illustrate a typical remanufacturing process. Give each student a copy and have them follow the process as you read it aloud.

3. Now tell the class they are going to take the flow charts one step further. Working individually or in groups the students are to find how the remanufactured materials become end products. For example, a student/group could research how steel, made from old soft drinks cans, is turned into new soft drink cans.

Recycle Research (cont.)

PROCEDURE (cont.)

4. Each child or group is to pick a product that is accepted for recycling. Then contact the manufacturer of the product. The students should ask for any literature the companies have on how recyclable materials become recycled items; graphics, diagrams and, flow charts are useful. Because many students will not know which companies use recyclable goods, it might be wise to contact your local recycling company. They should be able to provide contact information for the students.

5. After the information has been received the children or groups present their information to the class. This can be done orally, in written form or graphically as a flow chart.

EXTENSION:

1. Plan a trip to a facility where recycled goods are made.

2. Obtain samples of recycled products. Make a "before and after" display showing the recyclable materials (old paper, steel, etc.) and the recycled products they became (newsprint, steel cans, etc.).

3. Make a newsletter for your school to tell about recycling.

EVALUATION:

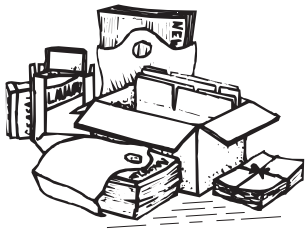
1. Do the children have a better understanding of why "recyclables" need to be separated?

2 Have the students improved their research and teamwork skills through this activity.

3. Will the class begin, or continue to purchase recycled products?

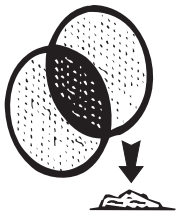
Paper Process Flow Chart

Paper is collected and separated into grades, according to market needs.

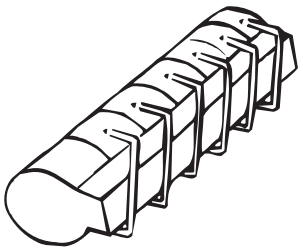


Paper is churned in a pulper with special soaps.

Pulp is filtered and screened to remove contaminants.



In floatation cells, air bubbles take inks, soaps and clay filler out of **pulp** to the surface to be skimmed off.

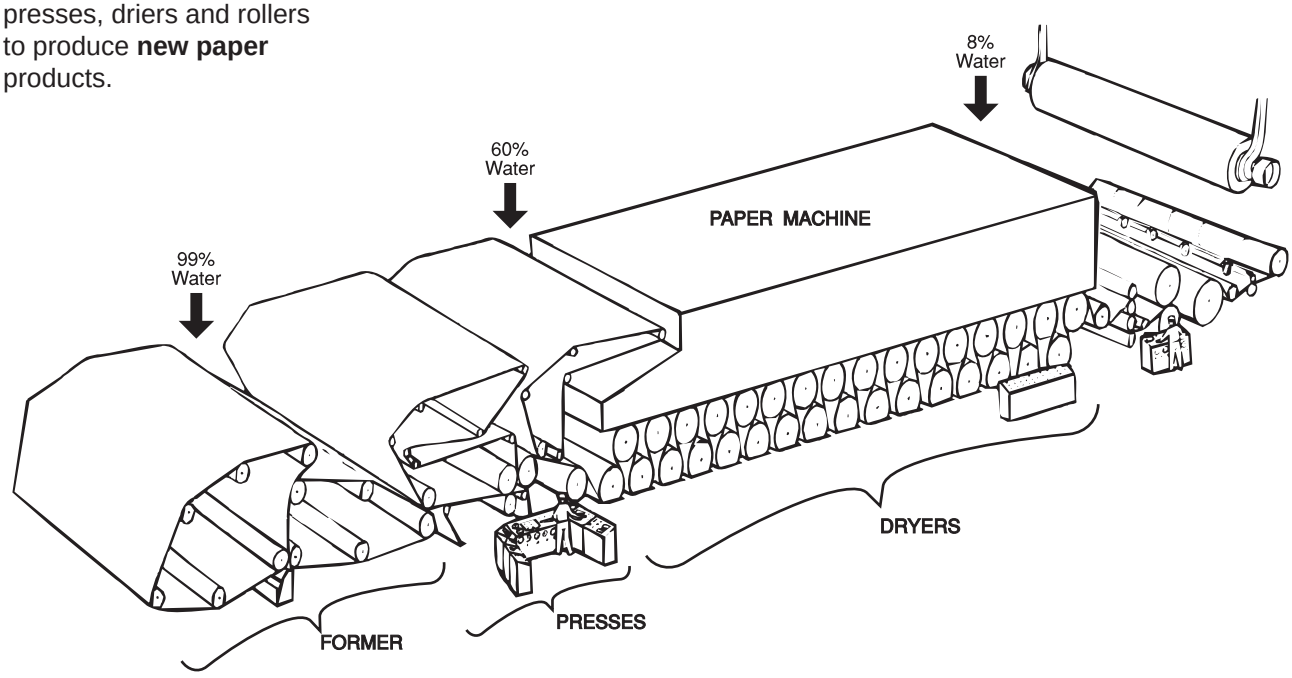


Ink can be recycled.

De-inked pulp is mixed with **new pulp.**

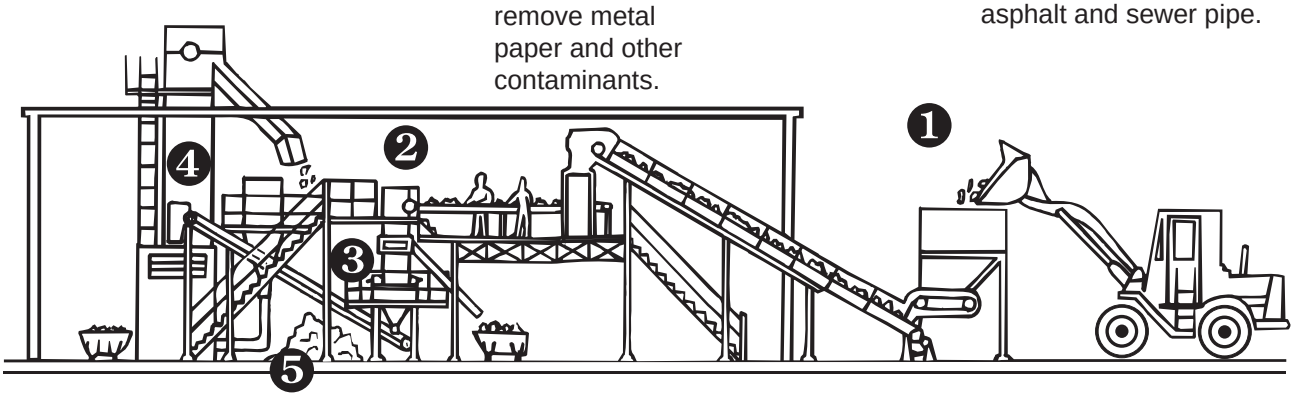
New pulp is added.

Mixed pulp goes through presses, driers and rollers to produce **new paper** products.



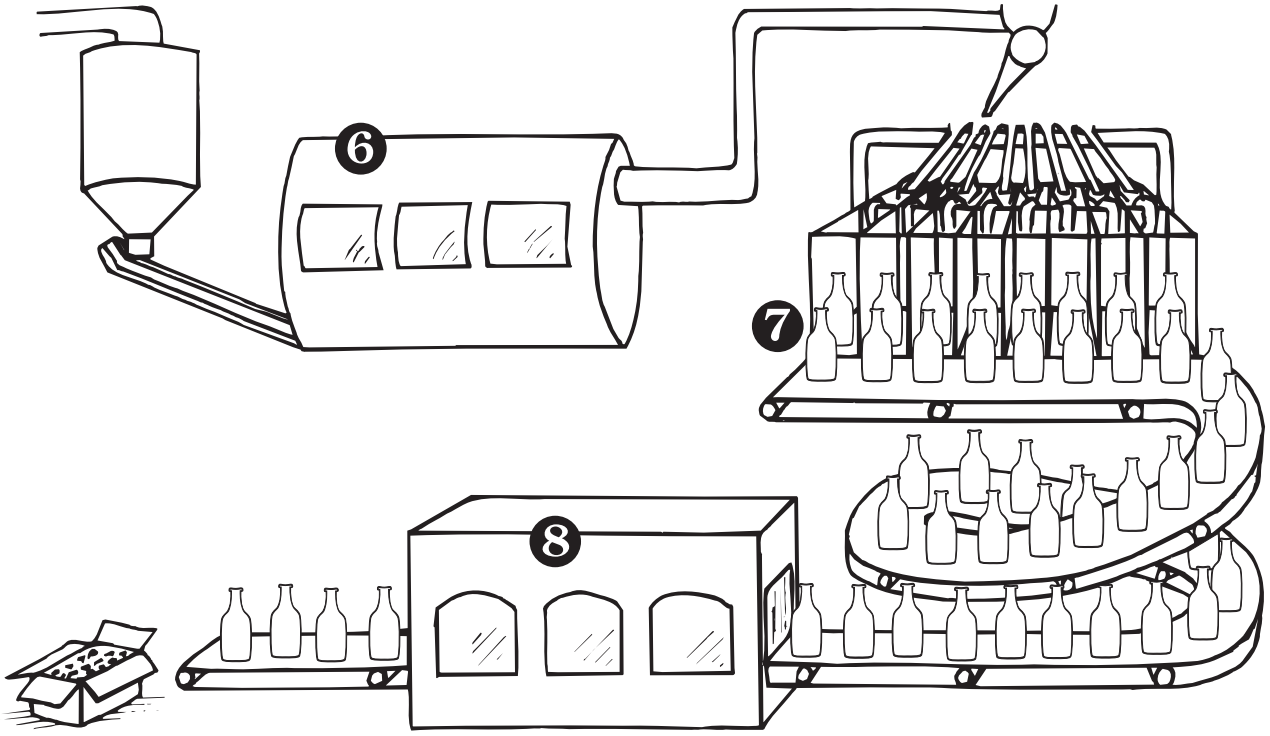
Glass Process Flow Chart

1. **Glass** is collected and separated into colours.
2. **Glass** goes through magnets to remove metal contaminants.
3. **Glass** is crushed into **cullet**. **Cullet** goes also through a beneficiation process using air and magnets to remove metal paper and other contaminants.
4. Clean **cullet** is produced.
5. **Cullet** is piled and later sent to be used in the glass production process. Some **cullet** is mixed with other elements to become fibreglass, reflective paint, asphalt and sewer pipe.



BENEFICIATION PROCESS

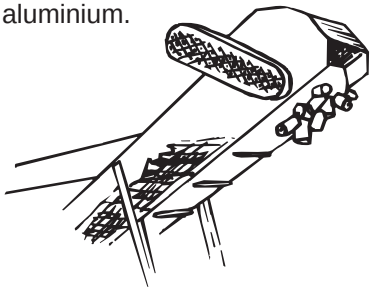
6. In furnace, **cullet** is mixed with a percentage of **virgin material** consisting of sand, limestone, and soda ash.
7. The melted **new glass** is cut off by weight and distributed into molds of bottles or jars.
8. The Lehr is a special oven which cools the **glass** slowly to strengthen it.



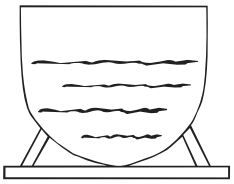
GLASS PRODUCTION PROCESS

Metal Process Flow Chart

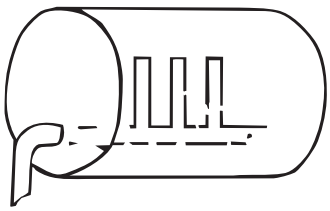
Metals are collected and separated by magnets and air into steel or aluminium.



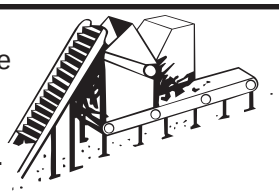
Steel cans are detinned by washing in caustic soda (also removing paper labels, food scraps, and other contaminants).



The dissolved **tin** is obtained by filtering the caustic soda solution.

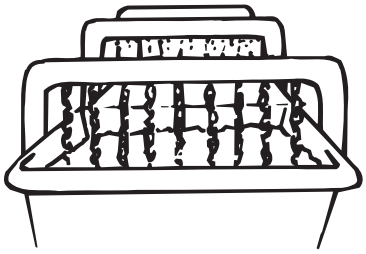


Aluminium products are shredded and delaquered.

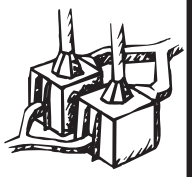


Cleaned **steel** cans are washed a second time, compressed into 230 kg bales and sent to steel mills.

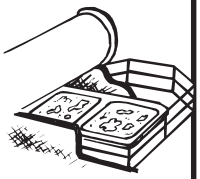
Electric current is sent through metal chains dipped into the solution attracting the **tin.**



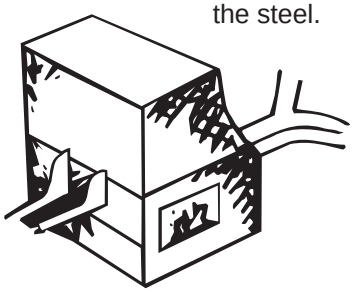
Shredded **aluminium** is melted down.



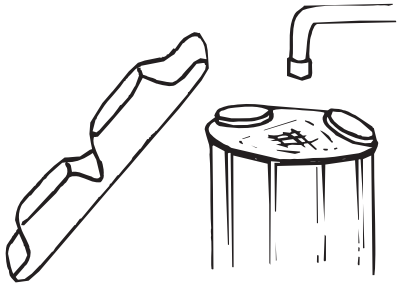
Aluminium is also recovered from dross in two step process.



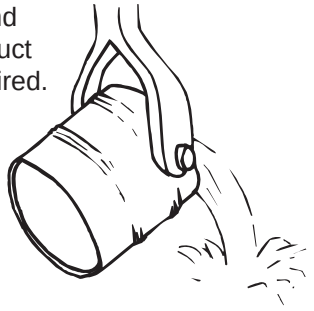
Steel bales are melted in a furnace to liquefy the steel.



Aluminium is processed into liquid or ingot form and shipped.



Molten **steel** is processed according to end product required.

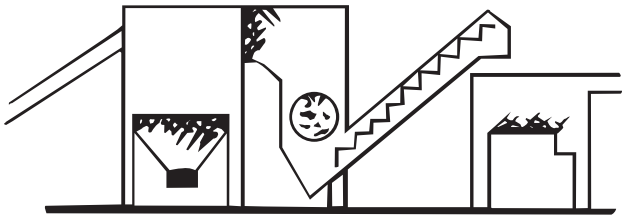


Tin is recovered by heat as a chemical powder.

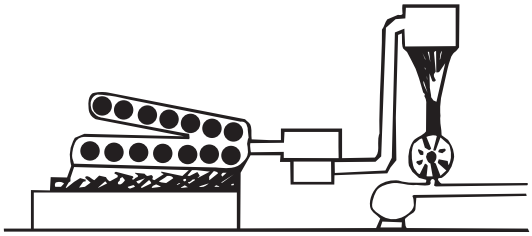
Plastic Process Flow Chart

Plastics are collected and sorted according to resin types or left mixed, depending on end markets.

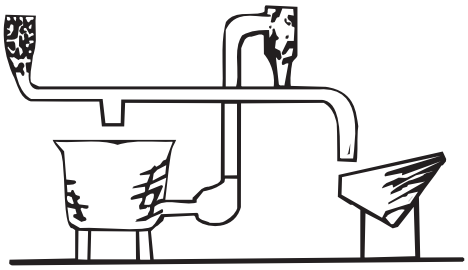
Plastics are ground into **flakes.**



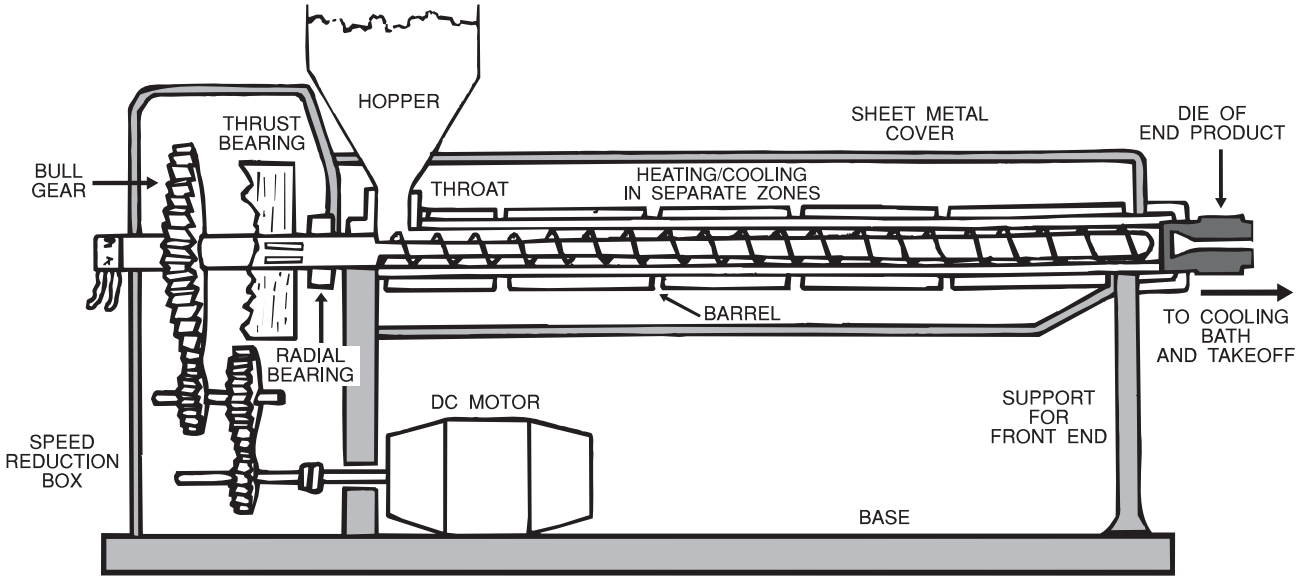
Flakes are dried and ground finer.



Flakes are washed and possibly further separated.



Plastic flakes are extruded into new products or pellets. The friction of the screw against the pipe (assisted by heating coils around the pipe) melts the flakes.



THE EXTRUDER AND ITS PARTS

Ecotalk

ABBREVIATION - a short form, usually only a few letters, that represent a longer word, i.e., PP which means polypropelene.

ACRONYM - a word formed form the first letter of several words. The word SCUBA is an acronym for Self Contained Underwater Breathing Apparatus.

BLUE BOX - a plastic box used to hold recyclable items.

COLLECTION - means to gather things. Collection is the part of recycling where your Blue Box is emptied.

COMMUNICATION - means getting information to another person or many people. There are many ways of doing this. Talking, writing, television, radio and newspaper are a few examples.

CONSUMERS - people who buy things.

DEPOT - is a place where people take their recyclable items. Depots are the opposite of a Blue Box. Instead of someone coming to you to collect steel, glass, etc. you take the things to them.

DIAGRAM - is a sketch or drawing used to explain how something works or looks.

EARTH FRIENDLY - products that are **not** harmful to the earth.

ENVIRONMENT - is the air, water and land that surrounds us.

FACILITY - a building designed to serve a particular purpose. For instance, a new ice rink would be a sports facility.

FLOW CHARTS - a drawing or chart that explains step by step how something happens or works.

GRAPHICS - picture, drawings or symbols.

GREEN - green is a word sometimes used by manufacturers to describe products that are suppose to be safe for the environment. However, sometimes the products are not safe for the environment.

LEGISLATION - are laws made by the government.

MANUFACTURERS - are the people or companies who make cars, pots, clothes and all the other things we buy.

MOBIUS LOOP - in the 19th Century a German mathematician named August Mobius made a loop by taking a strip of paper, twisting it once and joining the strip's ends. The strip was meant to be a toy

Ecotalk (cont.)

for children but today it is the symbol for recycling.

NON-RECYCLABLE - items that cannot be recycled. (see recycle)

PACKAGING - the wrapping around a product, i.e., the box that gum can come in is packaging.

PEER PRESSURE - when friends strongly influence other friends to do something. It can be negative or positive, like pressure to smoke or pressure to get good marks.

RAW MATERIALS - are the natural resources or recyclable materials used to make things. Trees are the raw material for paper. The trees are cut down and then manufactured. Old glass jars are the raw material for recycled glass jars.

RECYCLE - is the third "R". Recycling occurs when people collect and separate a special part of their waste. The part is special because it can be used to make new items. Old steel can be recycled to make new steel cans.

RECYCLED - is a word used to describe something that has gone through the recycling process.

RECYCLING - when a person uses a Blue Box or depot.

REMANUFACTUERED - something is remanufactured when it has been made into something else at a factory.

SEPARATION - to divide into groups. Recycling companies use separation to remove metals from plastic.

SYMBOL - is a drawing or picture. Symbols are used when there is no space for words. Poisons have a triangle and a skeleton as a symbol.

TERMINOLOGY - words common to a certain subject. For example, cat's eye part of terminology used in the game of marbles.

WASTE MANAGEMENT - what we do with our waste is called waste management. Good waste management helps the Earth.

Glossary

BALER: a hydraulic machine used to compress and bind recyclable materials into bundles making the materials easier to handle, store and transport.

BENEFICIATION: the process through which contamination is extracted from glass.

BLUE BOX: a blue plastic container distributed to households. It is used to store recyclable material and is placed at the curbside for collection. Most Blue Boxes are made of recycled plastic and can be recycled.

BOXBOARD: the third highest grade of paper used in the making of cereal boxes and similar packaging. It is often called cardboard but should not be confused with corrugated cardboard.

BRIQUETTE: a small densely compacted bundle used to make the transportation of recyclable material, especially metals, more efficient.

CAUSTIC SODA: another name for sodium hydroxide. Caustic soda is a brittle white solid with a soapy feel. When dissolved in water, it forms a strong alkaline solution useful for cleaning metals and other recyclables.

CLOSED LOOP RECYCLING: the conversion of used material into products the same as or similar to the original. This type of recycling allows materials to be re-manufactured over and over.

COMMERCIAL COMPOSTER: a machine specially designed to reproduce the ideal conditions in which organic matter will break down. Most do so at a pace much faster than natural composting.

COMMINGLED: recyclable materials that have been separated from other garbage but not from one another.

COMMODITY: an article of trade desired by purchasers, possessing utility and availability in limited supply.

CONTAMINANT/CONTAMINATION: any material that has a harmful effect on a product or the usability of a waste material, e.g. paper contaminants include inks, dirt and plastics. The presence of said unwanted material.

CULLET: glass that has been intentionally crushed prior to being mixed with other raw materials in the making of new glass.

"C" RATIONS: pre-packaged, self contained meals designed to be easily transported and consumed by military personnel in situations where mess halls or other catering cannot be used.

DENSIFY/DENSIFICATION: the compacting of materials especially metals into small conveniently sized bundles.

Glossary (cont.)

DEPOT CART: a container placed at a depot and designed to store a large volume (normally 235 to 430 litres) of recyclable goods.

DROSS: scum that rises to the top of molten metal. Reprocessing the dross produced during metal recycling can significantly improve the metal recovery rate.

ECOLOGO: an Environment Canada symbol licensed for use on products that have passed a set of criteria designed to test the product's environmental friendliness.

ELECTROMAGNETIC: a magnetic force produced when an electrical current is passed through a coil wrapped around another coil of magnetic material. Electromagnetic devices are useful when a constant magnetic force is not desirable.

FERROUS: of or containing iron. Through the use of magnets, ferrous products can be separated from other metals or items.

FLATTENER: a device used to compress aluminium and other metal cans.

FLUFFER: a machine that agitates paper before it is baled. Fluffed bales tend to hold together better than flat-baled paper.

FROSTED GLASS: decorative glass, produced by sand blasting or similar treatment.

GEOTEXTILE: any permeable textile used with foundation, soil, rock, earth or any other geotechnical engineering-related material as an integral part of a human made project, structure or system.

GRAVITY SORTING: a method that uses the principal of gravity and the weights of different products to separate said products from one another.

HIGH DENSITY POLYETHYLENE: (HDPE) a plastic used to make milk jugs and fabric softener containers. This type of plastic is represented by the Number 2 under The Plastic Container Code System.

ION(S): an atom or group of atoms which has either an excess or deficiency of electrons and is thus electrically charged.

KRAFT PAPER: a paper made predominantly from wood pulp produced by a modified sulphate pulping process. Its fibre length or grade is similar to that found in boxboard. A type of kraft paper item is paper grocery bags.

MARKET DEMANDS: the demand for a product created by people desiring the product, having the buying power to purchase it and the money to do so.

Glossary (cont.)

METAL RECOVERY: the percentage of metal recovered from the total material, after a recycling process. For example, if one tonne of aluminium was placed in a blast furnace and 800 kg was recovered after the remelting, then the recovery would be 80%.

MOBIUS LOOP: a figure designed by German mathematician August Mobius. The loop has no beginning or end. Three arrows were added to represent the three phases of recycling: collection, re-manufacturing, consumer recognition and purchasing of recyclable materials.

NATURAL RESOURCES: timber, water, minerals, fossil fuels and any other naturally occurring resources that can be used by humans. Because these materials are either fixed in quantity or require a long period of time to regenerate it is critical that they are carefully harvested and nurtured.

OPEN LOOP RECYCLING: a method of recycling where the end product is different from one collected. This includes the production of recycled products that cannot be recycled again (e.g. mixed plastic products).

ORGANIC GARBAGE: waste originating from living things and containing carbon (e.g. vegetables and meats).

PAPERBOARD: a grade of paper used to make containers. Paperboard is of a lower grade than boxboard and is used to make corrugated packages, food containers and other boxes. In general, paperboard is brown in colour.

PLASTIC CONTAINER CODE SYSTEM: a series of symbols comprised of a Mobius loop encircling a number between 1 and 7. The symbols help differentiate plastic resins and aid in all aspects of recycling.

POLYETHYLENE TEREPHALATE: (PET) a resin used in the manufacturing of soft drink containers. This material is represented by the number 1 under The Plastic Container Code System.

POLYVINYL CHLORIDE: (PVC) a plastic commonly used to produce vegetable oil containers. The number 3 is used to identify this plastic under The Plastic Container Code System.

POST-CONSUMER MATERIAL: materials previously used by consumers at locations such as homes, offices, stores and institutions that has been collected for recycling.

PRE-CONSUMER MATERIAL: excess material and defective material from manufacturing processes. It is suitable for recycling at either the place of generation or other facility but has never been in public circulation. In the steel industry it is called home scrap.

PULPER: a device that turns paper back into pulp.

Glossary (cont.)

RECYCLABLE: a term used to describe material or products that can be recycled. Technically most materials are recyclable, however the term is relatively meaningless unless programs to collect, separate and process the material exist.

RECYCLED: used as an adjective or verb; the term describes material or products that have been through the recycling process.

RECYCLED CONTENT: a ratio expressing the amount of recycled material in a product. It is normally given as a percentage of the product's total weight.

RECYCLING DEPOT: a central drop-off area for temporary storage of recyclable materials. Depots can range from fully staffed buildings to large unmanned containers.

SCRAP: another term for recyclable materials. There are three types of scrap: home scrap produced at mills or foundries, industrial scrap formed during manufacturing, obsolete scrap generated by discarded consumer goods.

SOURCE SEPARATION: the separation of material into specific categories at the point of generation or where the waste was created. Putting recyclables into a blue box is an example.

T.V. DINNER: a packaged, precooked, usually quick frozen, dish, requiring only heating before serving.

WASTE STREAM: a general term used to denote the waste material output of a household, area, location or facility.

WET/DRY SEPARATION: the diversion of waste into two waste categories: 1. organic waste called wet, 2. recyclable material labelled dry.

Resources

1. Bluewater Recycling Association
   P.O. Box 1330
   Grand Bend, Ontario
   N0M 1T0
   Phone: (519) 238-8661
   Fax: (519) 238-2330

2. Recycling Council of Ontario
   489 College Street, Suite 504
   Toronto, Ontario
   M6G 1A5
   Phone: (416) 960-1025
   (800) 263-2849
   Fax: (416) 960-8053

3. Ministry of Environment and Energy
   135 St. Clair Ave. West
   Toronto, Ontario
   M4V 1P5
   Phone: (416) 323-4321
   Fax: (416) 323-4564

4. Alberta Environment
   Oxbridge Place
   9820 - 106 Street
   Edmonton, Alberta
   T5K 2J6
   Phone: (403) 427-6267
   Fax: (403) 422-3571

5. British Columbia Environment
   810 Blanshard Street
   Victoria, British Columbia
   V8V 1X5
   Phone: (604) 387-9422
   Fax: (604) 356-6464

6. Manitoba Environment
   139 Tuxedo Avenue
   Building 2
   Winnipeg, Manitoba
   R3N 0H6
   Phone: (204) 945-7100
   Fax: (204) 945-5229

7. Saskatchewan Environment and
   Resource Management
   3085 Albert Street
   Regina, Saskatchewan
   S4S 0B1
   Phone: (306) 787-6107
   Fax: (306) 787-0930

8. New Brunswick Department of the Environment
   P.O. Box 6000
   Fredericton, New Brunswick
   E3B 5H1
   Phone: (506) 453-3700
   Fax: (506) 453-3843

Resources (cont.)

9. Newfoundland Department of
   Environment and Lands
   P.O. Box 8700
   St. John's, Newfoundland
   A1B 4J6
   Phone: (709) 729-2574
   Fax: (709) 576-1930

10. Nova Scotia Department of the Environment
    P.O. Box 2107
    Halifax, Nova Scotia
    B3J 3B7
    Phone: (902) 424-5300
    Fax: (902) 424-0503

11. Prince Edward Island
    Department of the Environment
    P.O. Box 2000
    Charlottetown, Prince Edward Island
    C1A 7N8
    Phone: (902) 368-5000
    Fax: (902) 368-5544

12. Québec Ministère de l'Environment
    3900 rue de Marly
    Sainte-Foy, Québec
    G1X 4E4
    Phone: (418) 643-6071
    Fax: (418) 528-0460

13. Government of Northwest Territories
    P.O. Box 1320
    Yellowknife, Northwest Territories
    X1A 2L9
    Phone: (403) 873-7343
    Fax: (403) 873-0301

14. Yukon Territory Environmental Protection
    Dept. of Renewable Resources
    P.O. Box 2703
    Whitehorse, Yukon Territory
    Y1A 2C6
    Phone: (403) 667-5939
    Fax: (403) 667-4727

15. Alcan Recycling (Ontario Office)
    317 Orenda Road
    Brampton, Ontario
    L6T 1G4
    Phone: (416) 458-1121
    (800) 268-7403
    Fax: (416) 458-1186

16. Consumers Glass
    100 West Drive
    Bramalea, Ontario
    L6T 2J5
    Mr. Paradiso
    Phone: (416) 796-4333
    Fax: (416) 796-4343

Resources (cont.)

17. Metal Recovery Industries Ltd.
    670 Strathearne Ave. North
    Hamilton, Ontario
    L8H 1N7
    Phone: (416) 549-9894
    Fax: (416) 547-1998

18. Ontario Soft Drink Association
    2 Sheppard Ave. East, Suite 1700
    Willowdale, Ontario
    M2N 5Y7
    Phone: (416) 224-2555
    Fax: (416) 224-1553

19. Ontario Multi Material Recycling Incorporated (O.M.M.R.I.)
    #3005, 40 King Street West
    Toronto, Ontario
    M5H 3Y2
    Phone: (416) 594-3456
    Fax: (416) 594-3463

20. Environmental Choice
    #200, 107 Sparks Street
    Ottawa, Ontario
    K1A 0H3
    Phone: (613) 952-9440
    Fax: (613) 952-9465

21. QUNO
    P.O. Box 1040
    Thorold, Ontario
    L2V 3Z2
    Phone: (416) 227-1121
    Fax: (416) 227-2112

Videos

Unless specified all videos listed are available for use through the Bluewater Recycling Association.

Consumers Glass, Glass Works.

Creative Video Productions, The Bluewater Recycling Association.

L & M Media, Paper.

Metal Recovery Industries Ltd., Steel Goes Full Circle.

Resources (cont.)

Speakers

1. The Bluewater Recycling Association
   P.O. Box 1330
   Grand Bend, Ontario
   N0M 1T0
   Phone: (519) 238-8661
   (800) 265-9799
   Fax: (519) 238-2330

2. The Recycling Council of Ontario
   489 College Street, Suite 504
   Toronto, Ontario
   M6G 1A5
   Phone: (416) 960-1025
   (800) 263-2849
   Fax: (416) 960-8053

3. Ministry of Environment and Energy
   135 St. Clair Ave West
   Toronto, Ontario
   M4V 1P5
   Phone: (416) 323-4321
   Fax: (416) 323-4643

4. Global Action Plan (G.A.P.)
   R.R.#4, 6080 Durham Road 23
   Uxbridge, Ontario
   L4P 1K4
   Phone: (416) 852-4786
   Fax: (416) 852-4786

5. Ontario Hydro
   Speakers Bureau
   700 University Avenue
   Toronto, Ontario
   M5G 1X6
   Phone: (416) 592-2322
   (800) 668-8500

6. Loblaws Inc.
   22 St. Clair Ave. East, Suite 900
   Toronto, Ontario
   M4T 2S8
   Phone: (416) 922-8500
   Fax: (416) 960-6998

7. Pollution Probe
   12 Madison Avenue
   Toronto, Ontario
   M5R 2S1
   Phone: (416) 926-1907
   Fax: (416) 926-1601

8. Greenpeace
   185 Spadina Avenue
   6th Floor
   Toronto, Ontario
   M5T 2C5
   Phone: (416) 345-8408
   Fax: (416) 345-8422

End Notes

[1]A Computer Model for Estimation of True Landfill Costs, prepared by Gartner Lee Limited for British Columbia Ministry of Environment and Energy, Victoria, British Columbia, V8V 1X5, 604-387-9422.

To order copies of discussion papers published by the Ministry of the Environment and Energy, call the automated phone line at 1-800-268-3747, and ask for area code 416 and phone number 323-4643.

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