I. Electronics We No Longer Use

Have you ever wondered where that old computer went when your family threw it into the trash? You have probably had a few cell phones in your family too, right? And in this next year, most of your families will probably consider buying a new television. Whether you have a working TV or not, where do you think your old TV will go? (Stimulate their thinking and get them focused on possibilities for destinations for used electronics)

What happens to computers, cell phones, palm pilots, printers, scanners, and all those other electronics when people are through using them? And what are some of the reasons that people stop using them?

- Equipment is broken or otherwise inoperative and can't be used.
- It is outdated or underpowered for use with new operating systems and software.
- It is no longer the existing technology, such as VCRs to DVDs.
- It is out of style and people buy newer versions to "keep in step." We have seen this with cell phones and palm pilots, or PDAs.

Okay, so we are no longer going to use some electronics. Where do old, broken or outdated electronics go when we're done with them?

- Many old electronic goods go into storage waiting to be reused, recycled or thrown away. The U.S. Environmental Protection Agency (EPA) estimates that as much as three-quarters of the computers sold in the United States are stored in garages and closets. When thrown away, they end up in landfills or large burners called incinerators—or more recently, are exported to developing countries.

- Many old electronic goods are exported to countries for reuse. Although there are obvious benefits of reusing electronics, export is causing problems because the old products are dumped after a short period of use in areas that don't have modern recyclers or hazardous waste facilities. We will cover this problem in more detail a little later.

-Some old electronics goods also go to recyclers: Recyclers may do many things, including reselling usable equipment or taking them apart for the metals they contain. Some even shred electronics into very small pieces that are sorted into metals, glass, and plastic, so that it can be shipped to a buyer for remanufacturing. Very often, new products can be made from recycled materials.

- These old, end-of-life unwanted electronics are referred to as E-waste or E-scrap—electronic garbage.

Question to ask Students: Let's guess a number. Can you give me an estimate of how much E-scrap you think there is in our country right now?

Answer: Recently, the United States Environmental Protection Agency estimated that there are over *two million tons* of E-scrap in the United States! Now, we know that a ton equals 2,000 pounds, so we're talking about *billions* of pounds of electronic waste, right? *4 billion pounds, to be exact!*

That's a lot of E-scrap! Can anyone give me ideas on how we could all do something to reduce this huge amount of electronic garbage?

One idea is that not all electronics are really "garbage."

- Some of them can be *refurbished and resold*. (Remember my mention of this earlier when I said that some electronics are exported to developing countries? And some of the refurbished and resold goods stay right here in the United States, where people buy and use them.)

Another idea is to *continue using old electronics* instead of going out and buying the newest thing. That's not always easy to do, but it's one way to make sure that pile of E-waste isn't so high! A lot of people hand down clothes, appliances, or furniture to members of their family. The same can be done with electronics.

Thought: As we become more dependent on electronic products to make life more convenient, the stockpile of used, obsolete products grows. Although used electronics represent less than two percent of the municipal solid waste stream**, if we continue to replace old or outdated electronic equipment at our current rate, the percentage will continue to grow. So that big pile of E-scrap will only get bigger if we don't stop it now.

**According to the U.S. Environmental Protection Agency, Americans generated 245.7 million tons of municipal solid wastes in 2005.

Now, the third idea in this list – the alternative to continuing to use your old electronics, and to refurbishing and reselling them, is to r*ecycle* your unwanted products.

A Brief Review and a List

So, once again—what is E-waste? It is anything electronic that is thrown away or sent out to be disposed of. Can you think of electronic products that you or your families have thrown out or have stored, because they don't work anymore and will be discarded eventually?

Computers
Monitors (CRT and Flat Screen)

Printers
TVs
Cell Phones
Palm Pilots/PDAs
Laptop/Notebook Computers
VCRs
Cameras
Video Cameras
Rechargeable Batteries: Nickel Metal Hydride; Nickel Cadmium; Lithium Ion

Recycle or Landfill?

Remember that 2 million tons of E-Waste I mentioned earlier? *Of that amount, about 1.5 to 1.9 million tons were primarily discarded in landfills. Only 345,000 to 379,000 tons were recycled.*

Why is Dumping Electronics in Landfill a Bad Thing?

Does anyone have some reasons why it is a very bad idea for these electronics to go into the garbage dumps, or landfills?

Resource Recovery

The primary reason to recycle anything is to reuse the earth's resources. Metal ores and petroleum (which is used to make plastic) are non-renewable resources. Non-renewable resources are things that are in limited supply—the earth will not make more of it. So once we use it, we must constantly *re-use* it, or risk running out!

Hazardous Materials

It's dangerous. Dumping electronic waste in landfills is very harmful to the environment and the people who live and work in the area of landfills, if toxic or poisonous waste begins to leach (or slowly leak) toxic substances into the air or water.

Why is Incinerating E-Waste a Part of the Same Problem?

Not all E-waste goes into landfills. Some is burned in large incinerators—or even worse, in open fires at garbage dumps or private property. Burning of municipal wastes has been done for thousands of years, but with E-waste this can be extremely dangerous to humans and animals by releasing toxic substances into the atmosphere.

The Main Toxic Substances From E-Waste

Main toxic substances that come from E-waste are Arsenic, Cadmium, Copper, Lead, Mercury, PCBs, PVC and Brominated Flame Retardants. Here are some facts about these substances:

Arsenic – A poisonous substance, used with another metal to form Gallium Arsenide and used in light emitting diodes (LEDs).

Cadmium – Found in primarily in older-style CRT computer monitors, power supplies and Nickel Cadmium (NiCd) batteries. If vapors from cadmium are breathed, the result could be fever, but prolonged exposure could result in pulmonary disease and even death. Additionally, Cadmium is a known carcinogen (causes cancer) and could also result in renal (kidney) failure. Dangers from Cadmium result from the burning of toxic wastes.

Copper – Found in many places in a computer, in electrical devices and electronics—especially wiring, CRT monitors, transformers, electric motors and printed circuit boards. Since Copper is not released from the body through the liver as many other substances can be, the body has a tendency to retain it, if it is ingested. Copper poisoning is similar to Arsenic poisoning and if untreated, can lead to brain and liver damage or even death, if excessive amounts are retained in the body.

Lead – Like Cadmium, Lead can be found mostly in CRT type computer monitors. A typical monitor contains over 4 pounds of lead. Lead poisoning has for decades been a toxic hazard in homes where lead-based paint has been used, but more recently, it has become a greater environmental hazard because of E-waste in landfills.

Mercury – Most often found in batteries, certain types of switches and specialized printed circuit boards. If Mercury leaches into the groundwater or nearby rivers and streams, fish can easily absorb it. It becomes dangerous when it enters the human body and can cause nervous system and even metal illnesses, as well as tremors. If inhaled, it can result in respiratory ailments. For these reasons it remains a biohazard.

PCBs – A chemical once widely used in capacitors, condensers, transformers and electrical equipment, PCBs (Polychlorinated Biphenyls) are highly toxic and a potent carcinogen. Beside the dangers of E-waste in landfills, PCBs can even become a problem if materials are not treated properly in the shredding and recycling operations

PVC – Or Polyvinylchloride, is a plastic. PVC, which can be found in E-waste in large amounts, is highly corrosive when burned and also results in forming substances called dioxins. A corrosive is anything that causes visible destruction or permanent changes in human skin tissue at the place where it touches the skin. Burning PVC releases hydrogen chloride, which if inhaled, mixes with water in the lungs to form hydrochloric acid. This can lead to corrosion of the lung tissues, emphysema and cancer.

Brominated Flame Retardants – Wiring, printed circuit boards and some other plastics inside computers may contain substances that protect the devices from fire or flame.

That's why you can find these in E-waste. The problem is that Brominated Flame Retardants generate Dioxins and Furans when E-waste is burned. If they are ingested through breathing, they can lead to severe hormonal disorders and cognitive (thinking processes) impairment.

We learned a little earlier that here in the United States, a lot of E-waste is still thrown into landfills, and the truth is that some is still being burned in open waste dumps and incinerators, or kilns.

But nowhere are toxic emissions and contamination from E-waste a greater or more tragic problem for a people and their environment, than in Asia.

Toxic E-Waste in Asia

Here's a story – about a scene that's all too typical in China. . .

A long line of trucks piled high with worn-out computers and electronic equipment pulls away from a group of container ships docked at a port in southeastern China. A short distance from there, the trucks dump their loads in what looks like a huge parking lot.

There, one sees pools of dark, oily liquid seeping from underneath mountains of E-waste. In outdoor workshop areas, poor Chinese workers use hammers to break up computers and toss bits of metal into brick furnaces that look like chimneys. Once they are opened up, the electronics release a host of toxic materials such as beryllium, cadmium, flame retardants, lead, mercury and PCBs. The plastics from these electronics, if allowed to break down or when heated, emit pollutant chemicals that can cause health problems such as birth defects and cancer.

Why do they continue to do this and risk being poisoned to death? For the money. Even so, they are paid only about $2 to $4 a day for their work.

E-waste is routinely exported by developed countries to developing ones, sometimes in violation of international laws. In 2005, 18 European seaports were inspected and it was found that up to 47 percent of waste destined for export, including E-waste, was illegal. In the United States, it is estimated that 50-80 percent of the waste collected for recycling is being exported in this way.

In 2000, Mainland China tried to ban the import of E-waste, but it is still arriving in Guiyu, located in the northeastern Chinese province of Guangdong. Guiyu is considered the main center of E-waste scrapping in China. In Guiyu, poor families, wearing no protective clothing, use dangerous gas burners to melt computer circuit boards and wires in large, uncovered pans. They do this to melt plastics and get at valuable metals like gold, silver and copper. Poor farmers in the city earn a few dollars by releasing gold through dangerous processes such as acid baths—pouring the acid from open basins over semiconductors to

remove their gold—without proper safety equipment. The used acid is then dumped into nearby rivers, polluting their source of drinking and bathing water. The people of Guiyu now have to bring drinking water in from other areas because their rivers are not safe to drink from. China alone produces one million tons of e-waste each year, and the amount is growing rapidly.

We have also found a growing e-waste trade problem in India. Twenty-five thousand workers are employed at scrap yards in Delhi alone, where 10,000 to 20,000 tons of E-waste is handled every year. One fourth of this amount consists of personal computers. Other E-waste scrap yards have been found in Meerut, Ferozabad, Chennai, Bangalore and Mumbai.

As international environmental laws become the issue in the next several years, this picture may begin to look much different. Developed countries such as the United States and Japan may have new laws, passed by Congress, that prohibit exporting used electronics to developing nations unless those countries have actually purchased those items to use, not recycle. Additionally, developing countries will slowly begin learning the technologies and processes to recycle their hazardous wastes in an environmentally-safe manner. Taiwan, a Chinese republic, has seen environmental change and is slowly cleaning up its toxic piles of E-waste. Some environmentalists in China say that progress is too slow, but even so, change is taking place.

Environmentally-conscious recycling companies in our country are looking toward the possibility of establishing their recycling technologies in China. If this occurs, that nation will begin seeing more changes for the better in their battle against toxic waste. Sims has been on the front lines of the battle against pollution from E-waste in the United States and many other areas of the world.

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The Solutions Start Here

First, a question: We've been hearing a lot about recycling. Who can tell me what the term *recycling* means? (Involve class in giving out definitions)

Here are two good definitions of recycling:

A recovery method of collection and treatment of a particular waste product, so it can be used again to manufacture a new product and minimize the waste stream.

Reuse of a part or parts of a product that would otherwise be totally thrown out.

So recycling can make new raw materials out of old materials, reuse parts of used electronics, and help keep the environment safe—that is, if the recycler is doing everything correctly!

Although recycling can be a good way to reuse the raw materials in a product, the hazardous chemicals in E-waste mean that electronics can harm workers in the recycling yards, as well as their nearby communities and of course the environment. So modern recyclers have to make sure that their own workers are protected from harm, too—both from the machinery that they operate and the E-waste they recycle.

In developed countries such as the United States and Europe, electronics recycling takes place in purpose-built recycling plants under controlled conditions. This also means that certain products can be recycled and others cannot. In many European Union states for example, plastics from e-waste are not recycled, to keep toxic substances like *brominated furans and dioxins* from being released into the atmosphere.

How They Do It

In modern, efficient recycling plants, here's the way electronics are dealt with:

When a batch of electronics arrives at the dock, it is given a special identification number that follows that shipment throughout its entire journey in the plant and out the door. Then it's sorted to remove packaging materials, determine what will go directly to get recycled, or what will be reused, recovered and eventually remarketed.

If electronics need to be recycled or only parts of them will be reused, they go to an area for disassembly. From there, major parts such as plastic cases, and other non-electronics are separated from the electronics. Parts that will be reused move to "audit lines" where they are checked to make sure they are in good working condition. They may be sold eventually. If not, they are recycled.

For instance, some computers, monitors, printers and other electronics are sent to a line that checks or "audits" them, refurbishes them and gets them ready to resell. Hard drives and other computer components may work well when tested, and are refurbished and sent to inventory for resale, or are eventually recycled.

The same applies to various Integrated Circuits, or "chips." Many can be recovered from computer printed circuit boards, refurbished, sorted, bagged and put into parts inventory to be resold on world markets. Remanufacturing and remarketing of electronics is a very good way to make sure the environment is kept free from unwanted "Electronic Garbage."

Non-working, obsolete or non-resellable computers, monitors and other electronics go to two main areas in the plant for recycling: The monitor shredder and the recycling line:

• The monitor line contains safety equipment, a shredder and special filters that keep harmful substances out of the air and away from the workers who operate the line. Steel in the monitors is pulled out by an overhead magnet. Copper-bearing plastics are separated from the rest of the materials by eddy currents (which cause them to become electromagnetic) and are sent with aluminum pieces to be recycled. The glass goes through a glass pulverizer, or crusher, then through a glass sizer. The leaded glass is separated from the non-leaded and each of these types of scrap is put into separate, specific containers and sent out to other processors who reuse the glass and metals.

• The electronics shredding line also contains safety equipment and filtration devices, to keep toxic materials in the electronics away from plant workers and out of the environment. First, batteries and toner are removed. In some cases, a check is made to see if there are recoverable integrated circuits. From here, materials to be recycled proceed to the shredding line and are prepared for Primary shredding and Secondary Shredding. In these 2 operations, the materials are made into smaller pieces in 2 stages. Just as with monitors that move down the monitor line, these computers, printers and electronics have steel, which is separated by magnets. Other "non-ferrous" (or non-iron-containing) metals are separated by eddy current. By the time the electronics are ready to send out of the plant for remanufacturing, they have been shredded to less than one inch in size! Then they are put into large containers and eventually sent to a metals refiner, where the plastics are safely burned off and the remaining metals melted and separated into specific types, sometimes alloyed with copper. Alloys are a combination of 2 or more metals combined together by the metallurgist, to make a new material. These metals are reused as raw materials in other markets and industries.

The electronics separation, teardown and shredding operations we've just learned about are also known as **Demanufacturing**.

We have to be careful to not send our electronics to recyclers who send them overseas. Companies that do all their computer recycling in the United States are called domestic recyclers. Another thing: We have to make sure that the recycler we choose does not put anything they process into landfills. More and more recyclers are being responsible and keeping the e-waste out of landfills, which means all of it eventually gets reused, either in the manufacturing of new products or in waste-to-energy conversion. That's a good thing!

Conclusion

Many people are working hard to make sure that more of the E-waste produced goes to responsible, environmentally-conscious recyclers—but we still have a long way to go. Each one of us can be part of the solution by getting the word out to everyone—our families and all of our friends—by making sure that all of our "end-of-life" electronics go to a place where they will be recycled, refurbished or resold – *not* to a landfill, incinerator, or even worse—exported.

The best tool we can use for being part of the solution is *knowledge* - and now you have a great head start with this E-waste study that we're finishing.

Here are two important questions:

- Do you think *any* recycler would be a good recycler for your used electronics?
- What's an effective way to find out who would be the best recycler for *your* used electronics?

- Ask questions, and read up on electronics recyclers in your area.
- Learn what others say about those companies, their services to you, your community, and if they are really recyclers or are just buying or collecting used electronics. If they are, do you know where the electronics are going?
- Many townships, counties and states are organizing electronics collection events so that residents of the community have a convenient way to recycle.
- Talk with your teacher and find out when the next event will be held in your area. Tell your family and friends about the event and let them know why it's so important to reuse, recycle and recover the E-waste that we generate. We all have a part to play in this continuing environmental story!

Questions & Answers:

Q: you said that computer monitors contain harmful chemicals like lead. Can they hurt me when I'm using my computer?

A: No. The harmful contents of the monitors are a hazard only when the monitors are thrown into a landfill, broken open, burned or shredded – or all of the above.

Q: At my house, we have a bunch of old computers, cell phones and other electronic stuff that we're storing in our basement. My dad said he didn't want to pay anyone to get rid of the computers, so they're just sitting there. Is there a place we can take the stuff for free so that it can either be reused or recycled like you said it should be?

A: Yes there is. Throughout the year, many communities host electronics take-back events where you can drop off your used computers and other gadgets for free. your own community usually puts out bulletins through newspapers, cable television and on posters advertising the events, and most of them are during the spring months—especially around Earth Day. That's the last week of April every year.

One Last Thing. . .

No matter what—when you, your family or friends decide to recycle old computers, cell phones, palm pilots, TVs or audio/visual electronics—<u>make sure you know where the used electronics are going after they are dropped off for recycling!</u>

As we have learned, this could be a life-or-death matter if the E-waste is going to be shipped to Asia where it will be improperly recycled, putting those countries' people at great risk.

One easy way to know for sure where your E-waste eventually winds up is to make sure that all your used computers and other electronics listed in this study go to a responsible electronics recycler who puts the products to reuse!