CHAPTER	16
TITLE	Old World Successes and New World Challenges: Reducing the Computer Waste Stream in the United States
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OVERVIEW	This chapter considers the toxic waste stream of computers and computer components, and encourages us (i.e., technology-inclined academics) to consider even more carefully what sort of environmental impact we will be making as our projects and programs succeed. The current picture, incidentally, is both bleak and hopeful. The Environmental Protection Agency (EPA) says that from 2000 to 2007, upwards of 500 million personal computers will enter the municipal solid waste stream in America. This is a crisis not only because of the amount of computers for disposal, but also because of their toxic byproducts, including lead, mercury, and cadmium. This chapter looks at current techno-ecology patterns in the United States, identifying their potential and shortfalls, and, in order to find a solution to the challenges of the technology waste stream, compares them to similar activities in Europe, with a focus on Sweden, the most progressive nation on this issue. Unlike the top-down approach of the Europeans, North American consumers have formed grassroots organizations to confront the escalating computer waste stream crisis. We examine ideas and activities of American grassroots groups and suggest further approaches based on established European models to enrich technological sustainability in our institutions.
TAGS	Apple, authorization, BAN, Basel Action Network, Basel Convention, California, chemicals, chemicals, China, collection, Computers, consumers, corporate, Dell, developing, electronic, El-KretsenEU, European Union, evaluation, ewaste, e-waste, global, Gordon Moore, grassroots, hazardous, Kristi Apostel, Moore's Law, Norway, producers, REACH, recycle, registration, Shawn Apostel, toxic, toxin, trash, United States, Waste Electrical and Electronic Equipment, waste management, waste stream, WEEE
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Old World Successes and New World Challenges: Reducing the Computer Waste Stream in the United States

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These words began their journey on a patched together, 8-year-old home computer (see Figure 1), and they continue on a PC that is one in a line of several, all of which differ in appearance, function, and speed. Like our home computer, the one that hosted these words as we composed this chapter was a mix of components from other, now dysfunctional, computers. This computer lived in the Finlandia University Teaching and Learning Center, a tutoring facility equipped with many hand-me-down machines from various offices and departments in the school. These machines include one that serves as a reading tool for students with disabilities, and one that never quite works correctly and usually has a sign taped to the front that reads “being rebooted,” followed by the most recent maintenance date available. Another computer hosts an old set of headphones used more for pleasure than for teaching.

Figure 1. Our patched-together desktop is now in storage, awaiting the completion of our vacation home, where it will once again host our ideas—as well as our children’s software. Photo by Shawn Apostel.

Although the computers in this facility are not the same as when originally purchased, they are, in fact, anomalies, according to “Moore’s Law,” born out of Gordon Moore’s (1965) observations that the average computer becomes obsolete within a 2-year time span. Moore, the co-founder of Intel, even predicted that this 2-year factor could surpass itself: “Certainly over the short term this rate can be expected to continue, if not to increase” (online). Writing for *The National Geographic*, Chris Carroll (2008), took this idea one step further by pointing out that “an unstated corollary to ‘Moore's law’ is that at any given time, all the machines considered state-of-the-art are simultaneously on the verge of obsolescence.” Similarly, trueCycle (2005), a self-proclaimed leader in asset management and recycling services, commented that “in 1997, the average life span of a computer was four to six years” (online). With such short life spans, computers—and their mounds of miscellaneous equipment—make up a rapidly growing amount of waste in today’s landfills. Not only are they filler for landfills across countries and continents, computers also carry with them an array of issues that every computer user should consider when contemplating the disposal of the old and the bringing in of the new. From hazardous substances inside computers to legislation on how, where, and who should recycle them, and from homes to businesses to schools, computers and the burgeoning electronic waste stream they help create are an undeniable part of the trash we produce.

Surprisingly, the amount of computers recycled each year in the United States is on a downturn in comparison to the increasing number of computers purchased. This imbalance creates a computer waste stream crisis, especially dangerous due to the hazardous chemicals—such as lead and mercury—that litter computer waste. The crisis has a “trickle-down effect”: Poor countries often receive old computers and the waste they generate from wealthier countries (Carroll, 2008). Some areas of the world are, however, confronting the computer waste stream head-on. The European Union (E.U.) has been a forerunner in this arena since 2003 with its Waste Electrical and Electronic Equipment (WEEE) Directive, which helps regulate hazardous electronic waste disposal while also working with producers and consumers to create a model system for responsible electronic waste disposal. Unfortunately, the United States (U.S.) has been slow to design similar federal laws, so some states, such as California and Massachusetts, are taking matters into their own hands. Several computer manufacturers—monitored by independent watchdogs—have also claimed some responsibility, while grassroots organizations design and enact their own methods of electronics recycling. Moreover, suggestions and solutions for how to take responsibility for our outdated computers demonstrate that the computer waste stream is a significant issue that, with time and willpower, can best—and sustainably—addressed.

In this chapter, we discuss the perilous global landscape of e-waste, perhaps one of the most critical sustainability-related issues we face. If we continue to erode our natural environment, then sustaining our workplace environments—our computers labs, our classrooms, and the other spaces in which we teach and research—is much more than a local matter, especially when viewed from a global, ecological perspective, such as we propose here. After discussing the perils of e-waste, we review some of the innovative directions taken by the E.U. for regulating waste, and we examine some of the steps being taken by U.S. state governments, by U.S. corporations, and by U.S. grassroots organizations. We close with recommendations for ways that educators can seek to reduce their department’s, program’s, and institution’s electronic waste stream. An appendix is included that charts efforts to slow the computer waste stream in the E.U. and in the U.S. (see Appendix 1).

A LOOK AT THE NUMBERS: E-WASTE ON THE RISE

Today, many people are aware that some old and unwanted, even intentionally recycled computers, end up in China, India, and various developing countries, where they are picked apart by hand, exposing impoverished workers to the hazardous components inside. Not until the National Safety Council and Stanford Resources, Inc. combined forces to conduct research on this topic did speculation on these issues become more than guesswork. As noted on the National Safety Council's Web site, "relatively few old PCs are being recycled and…most are stored in warehouses, basements, or closets or have met their end in municipal landfills or incinerators." The research, compiled in a 2006 report titled *Electronic Product Recovery and Recycling Baseline Report: Recycling of Selected Electronic Products in the United States*, "used data from 123 firms, including recyclers, third-party organizations that accept equipment for refurbishment and subsequent resale or donation, original equipment manufacturers (OEMs), and large corporate users of electronic equipment" (online). In 1998, 20.6 million computers in the United States became outdated; out of those, only 2.3 million were pledged for recycling. On their eCycling Web site, the U.S. Environmental Protection Agency (EPA; 2006), pointed out that, in the same year, "more than 9.7 million units (275 million pounds) of electronic equipment were recycled" and "6 percent of PC CPUs were recycled" (online). If the *Electronic Product Recovery* report numbers are consistent with those of the EPA, then the truth of the matter is that out of the 20.6 million outdated computers, the 6% actually recycled amounted to only 1.2 million. Indeed, as the EPA admitted, "the actual percentage of electronics recycled is low" (online). Over the past decade, these numbers have remained relatively unchanged.

Although the EPA predicted recycling in the electronics industry to increase 18% each year between 1998 and 2007, the amount of computers entering the waste stream has also risen dramatically. In her book *Garbage Land: On the Secret Trail of Trash*, Elizabeth Royte (2005) authenticated these numbers when she reported that the electronic waste stream in America is growing practically three times faster than the entire municipal waste stream, and, "according to the National Safety Council, nearly 250 million computers will become obsolete between 2004 and 2009" (p. 165). Furthermore, the Basel Action Network (2005), or BAN—which is the sole global organization concentrating its focus on "Toxic Trade," including trade in toxic wastes, toxic products, and toxic technologies—also reported that:

> The electronics and information technology industry is the world's largest and fastest growing manufacturing industry. As a consequence of this remarkable growth, combined with the phenomenon of rapid product obsolescence, discarded electronic equipment, or e-waste, is now recognized as the fastest growing waste stream in the industrialized world. (online)

Beyond waste stream growth and recycling predictions is the reality of what must be done with the refuse—discarded monitors, keyboards, printers, and mice. Recycling of e-waste is no easy task, and the difficulties of this job rise exponentially when we realize the amount of toxins people come into contact with every day when recycling old computer equipment.

THE TOXIC TRAIL: THE DANGERS OF IMPROPER RECYCLING OF E-WASTE

Exploring the nature of recycling computers and accessories, BAN (2005) recognized the problem of sugarcoating the task while overlooking very real dangers, noting that:

> too often, justifications of "building bridges over the digital divide" are used as excuses to obscure and ignore the fact that these bridges double as toxic waste pipelines to some of the poorest communities and countries in the world. While supposedly closing the "digital divide," we are opening a "digital dump." (online)

In many cases, the wealthiest countries are unknowingly dumping unusable and toxic e-waste products by sending supposedly recycled computer shipments to countries without the facilities to adequately dispose of the by-products. Assuming these products will be reused and recycled, wealthier countries are actually contributing to polluted air and contaminated drinking water—problems that obviously affect local areas, but also expand quickly beyond local borders to pose global problems. BAN led the effort to address this issue with the Basel Convention, ratified by 165 countries and signed by 168 (the three who signed the document but failed to ratify it were Afghanistan, Haiti, and the United States—the U.S. being the largest global producer of waste per capita; BAN, 2007, online).

Tam Harbert (2006) explored the issue of toxic e-waste in a recent online article in *OnEarth* magazine, a publication of the Natural Resources Defense Council. According to Harbert, too often the developing countries engaged in computer recycling "are increasingly victimized by a disproportionate burden of the world's toxic cyber waste" (online). As the United Nations Environment Programme (2004) has reported, 4 million personal computers end up in China every year. Furthermore, out of the mass of "recycled" computers that find their way to Nigeria, BAN (2005) detailed that:

> as much as 75% of the imported used computer equipment is "junk" and not economically repairable or resalable. And according to other local experts on the trade, an estimated 500 containers of used computer scrap of various condition and age, enter the country each month. Each container is said to contain about 800 computers or monitors, thus representing about 400,000 arriving each month. (online)

As overwhelming as the sheer amount of obsolete computers is, even more distressing is the amount of toxins released when these computers are broken down for recycling. Ill-equipped laborers in developing countries are exposed to toxins when they disassemble computers and other electronics. BAN (2005) has given an account of toxic trash heaps, official and unofficial, in Nigeria, where toxins leach "into the near-surface groundwater and are routinely burned, emitting airborne toxic chemicals such as dioxins, polycyclic aromatic hydrocarbons and heavy metals" (online). Like Nigeria, Ghana is also struggling with massive amounts of damaging e-waste, as Greenpeace (2008) reported in a YouTube publication. Finally, it is notable that such chemical hazards not only affect individual workers and local communities, but these toxic threats can also affect an entire country by hindering development of the country's recycling infrastructure. (For more detailed discussion of the impact of e-waste on developing countries, see Carroll, 2008.)

STEPS TOWARD RESPONSIBLE E-WASTE MANAGEMENT: THE EUROPEAN UNION EXAMPLE

Regulating the E-Waste Stream

Some areas of the world have sought to make immediate changes to their waste management systems. The E.U., for example, passed legislation in 2003 that, in part, requires careful watch of toxins contained in electronics and electrical equipment. The legislation, known as the Directive on Waste Electrical and Electronic Equipment (WEEE), allows for disposal of hazardous chemicals contained in electrical equipment. The Directive, in Annex II, notes that substances including polychlorinated biphenyls (PCB), mercury, batteries, cathode ray tubes (CRTs), chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), hydrocarbons (HC), and asbestos must be removed before the equipment is landfilled.

Figure 2. Hazardous materials are separated at this collection site in the E.U. country of Sweden. These signs indicate that paint, batteries, oil, solvents, pesticides, and corrosive substances may be responsibly disposed of here. Photo by Shawn Apostel.

The E.U. continues to see a need for restrictions when dealing with hazardous chemicals. Two additional pieces of legislation, known as Registration, Evaluation, and Authorization of Chemicals (REACH) and Restrictions of Hazardous Substances (RoHS) have already passed and, as Harbert (2006) proclaimed, foster a positive example in the global landscape, where countries like Nigeria have faltered. According to Harbert, "a worldwide wave of legislation may not only stem the tide of e-waste but ultimately force manufacturers to change the way electronics are designed. The European Union was the first to adopt these new laws, and China is now following suit" (online). Specifically, RoHS restricts the amount of toxins manufacturers can use in an extensive range of products with electronic circuitry. Companies have to, instead, use non-hazardous components, such as "lead solder with tin, silver, or copper alloys" (Harbert, online).

REACH, ratified December 18, 2006, by the Council of Environment Ministers, was enforced in June 2007 (European Commission, 2007). The goal of REACH is to provide a means for the earlier detection of harmful chemical substances to protect both human life and the environment. What makes REACH stand above its predecessors is the freedom it permits manufacturers, a freedom that might not exist had the E.U. not formulated the WEEE Directive. In particular, REACH:

> gives greater responsibility to industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers will be required to gather information on the properties of their substances, which will help them manage them safely, and to register the information in a central database. A Chemicals Agency will act as the central point in the REACH system: it will run the databases necessary to operate the system, co-ordinate the in-depth evaluation of suspicious chemicals and run a

> public database in which consumers and professionals can find hazard information. (European Commission, online)

REACH also encourages for gradual substitution of the most hazardous chemicals when appropriate alternatives have been identified. The emphasis on restriction, care, and stewardship is thus balanced by an emphasis on capability and competitiveness. That is, encouraging research and development activities to encourage all producers to devote development efforts to appropriate alternatives.

Legislating Consumers and Producers

Legislation in Europe goes well beyond regulating chemical substances—it also touches the individual consumer. The WEEE Directive (2003) extends to "all operators involved in the life cycle of electrical and electronic equipment, e.g., producers, distributors and consumers" (p. 26). The Directive includes consumers in electronic waste stream reduction. Measurements of success are also laid out in the Directive, for all E.U. member states must have ensured, by December 31, 2006, a collection amount of at least four kilograms, or just under two pounds, of WEEE on average per inhabitant per year. Plans are also in the works to increase this target number within the next 2 years. For these numbers to become a reality for the average inhabitant of a European home, the Directive requires that "convenient facilities should be set up for the return of WEEE… where private households should be able to return their waste at least free of charge" (p. 25).

WEEE standards carry over to producers, who must "provide at least for the financing of the collection, treatment, recovery and environmentally sound disposal of WEEE from private households deposited at collection facilities" (Directive, 2003, p. 30). Producer responsibility is, in part, what makes WEEE such a radical and innovative regulation. To abide by the Directive, producers must be responsible for the costs of recycling their products, and these costs must already be covered at the time a new product is placed on the market. Producer responsibility is essential to the recycling of WEEE, but recycling may not be the only option for electronic equipment seemingly at the end of its cycle—reuse, upgrade, and repair are other possibilities.

Providing for so many items and so many different stakeholders in the electronic waste stream is a daunting task for one legislative council to enforce. The European Parliament thought of this as well, and, consequently, delegated the responsibility of enforcement to the E.U. member states and their communities.

Sweden: An Exemplary Model of Enforcement

As a member of the E.U., Sweden has been a model for enacting the essential criteria outlined in the Directive. To reach exemplary status, Sweden began enforcing the Directive well before the deadline of August 2005. Working through its own service company, El-Kretsen ("the electricity circuit"), in 2004 Swedish collection sites acquired 87,000 tons of electrical waste—equal to 22 pounds per person in Sweden. This waste was recycled in 32 different treatment facilities located in Sweden and Norway, and contracted by El-Kretsen. In line with the WEEE Directive, El-Kretsen (2005) focuses on producer responsibility, making "Swedish companies who import, manufacture, or sell electrical products liable to offer its customers, households as well as businesses, an opportunity to leave corresponding discarded products for recycling" (p. 3; see Figures 2 and 3).

Figure 3. A “Farligt Avfall” (Hazardous Waste) collection site in Sweden. Collection sites like this one (just outside Vetlanda in Småland) are located throughout the country and do not charge a disposal fee. Photo by Shawn Apostel.

El-Kretsen (2006) also includes private individuals, small businesses, and municipalities in its efforts. Cooperation among different stakeholders is, therefore, integral to reducing the electronic waste stream in Sweden, where even small neighborhoods in rural areas work with their municipalities to utilize collection sites, where anyone can go to drop off electronic waste free of charge. This has led to landmarks such as Sweden and El-Kretsen setting a world record in 2005 for recycling electronics, when 35.2 pounds of products per person were diverted from landfills.

When an end-of-life electronic product is brought to an El-Kretsen collection site in Sweden, it takes an extensive and careful journey down the stream toward recycling. At the collection sites, all electrical products are sorted into six different categories and then transported to a specialized recycling plant. The electronic product is then disassembled and the toxins are removed and organized for special treatment. When these tasks are completed, the separated materials are finally recycled. In 2004, the amount recycled increased by 10%; in 2005, the increase jumped to 28% (El-Kretsen, 2006, p. 8).

Efforts to Regulate E-Waste in Other Countries

Fortunately, Sweden is not a lone success. Even non-E.U. countries are combating the growing problem of electronic waste. Consider China, which has recently introduced and is in the process of approving new laws, proposed in tandem with enforcement approaches:

> China's RoHS directive may be even more stringent than the European version; it restricts the use of the same six materials—lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs)—but allows fewer exemptions in the range of products affected. (Harbert, 2006, online)

Covering more than the restriction of hazardous chemicals, producers must include a disclosure with their products and must submit them to Chinese labs for certification. The disclosure will inform consumers whether or not the products contain toxic substances and "how long before these start breaking down and leaching into the environment, and whether the product[s] can be recycled" (Harbert, online). However, even these positive signs in China do not mean all is well. As a recent *National Geographic* report noted, the stricter regulations in China have led to the increase in e-waste in other Asian countries such as Malaysia due to illegal shipment of e-waste and toxic chemicals out of China (Carroll, 2008, p. 75).

THE SITUATION IN THE UNITED STATES

Legislation at the State Level

Unlike the E.U., China, and Australia, the U.S. government has been reluctant to pass top-down legislation regarding the reuse and recycling of computer waste. Instead, the U.S. prefers that companies and consumers take action; getting companies to agree, however, has proven difficult. For example, in 2004, after years of negotiating, personal computer and television manufacturers abandoned an effort by industry leaders, environmental groups, and government agencies to find a way to reduce electronic waste, because they couldn't agree on how the recycling fee should be passed on to consumers: at the point of purchase (preferred by television manufacturers) or when these products reached the end of their usefulness (preferred by the PC industry; Harbert, 2006, online).

With no federal laws governing the disposal of electronic waste, individual states are forced to implement their own plans, a highly inefficient method from a business standpoint (i.e., potentially 50 different laws for computer manufacturers to follow). A handful of states have passed laws prohibiting the disposal of cathode ray tubes (CRTs) in landfills, requiring that they be recycled at state-certified locations, and roughly half of the states in the U.S. have passed or are working on some form of electronic recycling laws (Harbert, 2006). One of the more progressive states is Massachusetts, which, with its state contract with ElectroniCycle, recycles all televisions and computers disposed of in the state, to recover 10 million pounds of electronics per year:

> technicians refurbish between 5 and 10 percent of their computers for resale; send another 5 to 10 percent to specialty repair houses; and smash the rest into fifty different categories of scrap, including plastic, copper, aluminum, barium glass, and leaded and mixed glass (which is recycled back into cathode-ray tubes). Reusable integrate circuits and memory cards are gleaned, then circuit boards are sent off site for recovery of gold, palladium, silver, and copper. Nothing goes overseas. (Royte, 2005, p. 172)

Like Massachusetts, California is concerned with contaminants in discarded electronics. Consequently, recycling of some products is regulated by state health and safety code hazardous waste laws. California also recently approved new laws regarding the management of CRTs in monitors and televisions; companions to this law include two bills on electronic waste passed during the 2001–2002 legislative session (California, 2007).

Other states that have passed or are considering e-legislation include Maine, Michigan, Minnesota, New Jersey, Oregon, Rhode Island, Washington, and Wisconsin. The efforts of

states like these are commendable because, as forerunners in television and computer recycling, they encounter opposition from reluctant companies. For example, several major producers of electronics—including Sharp, Panasonic, and Philips—have opposed Massachusetts's e-bills, including a proposed producer take back plan, despite requirements to take-back their products in Europe (Computer TakeBack Campaign, 2006). Ironically, these companies use the WEEE initiatives in Europe to talk about how ecologically friendly they are:

> As an environmentally advanced company, Sharp is taking a proactive role in the global community [and]. . . will be actively involved in the business of recycling. Sharp is also working to accumulate know-how in product design that will facilitate recycling and is pursuing development of new recycling-related technologies for the E.U. region. (Sharp, 2007, online)

Panasonic (2004) has actually agreed to establish a take-back recycling scheme "in each Member State of the E.U. when Industry or Sector related collective schemes are not feasible or not cost competitive, [and to] supervise the entire recycling operations where necessary" (online)—this from the same company that opposed Massachusetts's legislation. Environmental considerations, admittedly, were not historically a major part of the electronics industry, which instead has focused, quite successfully, on developing the smallest, cheapest, and most quickly produced electrical equipment possible. The same ingenuity can be applied to reducing and recycling electronic waste; some promising moves in this area are made by producers of computer equipment, including Hewlett Packard (HP), Apple, and Dell.

U.S. Corporate and Grassroots Organization Efforts

HP operates a trade-in site that gives consumers credit for old computer equipment, including non-HP products. Consumers receive coupons for new HP purchases in exchange for their old monitors, central-processing units, and laptops, and also smaller items like PDAs, printers, and digital cameras (ComputerTakeBack Campaign, 2006). Dealtree.com provides a trade-in service for several companies, as well as checks or gift certificates for old computer equipment, depending on the brand.

Apple doesn't offer money or gift certificates for their old products, but they do have an environmentally friendly program. In 2006, Apple announced an expansion of its recycling program to include free computer take backs with the purchase of a new Macintosh system. However, these purchases have to be made at the Apple Store online or at an Apple retail store. When customers purchase a new Mac from these locations, they can request free, postage-paid packaging in which to ship their old Macs for environmentally friendly recycling, without the fear of their used computers being shipped overseas.

Dell offers more than Apple in its recycling plan, with free recycling for any brand computer products with the purchase of a new Dell, as well as free recycling of any Dell product whether a consumer is purchasing a new product or not. In addition, Dell (2007) has pledged to employ the same standards globally, and would like other computer companies to follow suit:

> To ensure a level playing field amongst all producers, Dell supports legislation under which all producers are responsible for proper end-of-life management of their electronic products consistent with our policy. Dell supports a policy framework that provides for individual producer responsibility for electronic products at the end of their useful lives. Individual responsibility requires each producer to work with consumers to properly collect and manage that producer's electronic products in an environmentally responsible manner. (online)

Which company is the best at recycling its own products is up for debate, largely because there is no uniform way to report what electronic waste is recycled. The As You Sow Foundation, an organization committed to ensuring that corporations and other institutions act responsibly toward sustaining both the human condition and a healthy environment, has conducted research on the recycling records of several large companies. The Foundation (2006) discovered that

> five major companies had disclosed electronics take back figures for portions of 2002, 2003 and 2004. They are Apple, Dell, Fujitsu, HP and IBM. Complete estimates for all five were available for only 2003. Our tally indicated that in absolute numbers of computer equipment measured by weight recycled in 2003, HP led its peers followed by IBM, Fujitsu, Dell and Apple. But looking at a rate of return analysis compared to sales for each company 7 years ago, we found that IBM was the take back leader, recycling 19% of equipment sold in 1996 followed by Fujitsu (13%), HP (7%), Dell (4%) and finally Apple (2%). Only Dell and HP have released data for 2004. Dell appears to have significantly improved its take back rate in 2004 to 9%. (online)

The problem with these numbers, according to As You Sow, is that each company had a different way of measuring what they recycled. For instance, IBM includes industrial products—large server units, for instance—in its weight tallies, and HP counted printers. Dell's numbers included electronic waste collected at recycling drives they funded.

Until a standard matrix is agreed upon, it will be difficult to measure and, therefore, evaluate the progress of companies producing electronic and computer equipment; several grassroots organizations, however, are attempting to address this issue. Among them are the Silicon Valley Toxics Coalition, the Basel Action Network (BAN), and the Computer TakeBack Campaign. These organizations created the "Electronics Recyclers Pledge of True Stewardship," which companies can sign, and, in return, have their name distributed to recyclers as a guarantee that the company follows "the best industry practices in environmentally sound management" (Computer TakeBack Campaign, 2002, online). Included in the nine-point pledge are promises regarding appropriately treating hazardous electronic waste, using the least polluting options for intermediaries, obtaining bonds to cover costs associated with closing an electronic waste facility, and continuing support for Extended Producer Responsibility (EPR) programs and laws. EPR is the credo of the Computer TakeBack Campaign, an organization formed by several environmental and social justice groups. The idea behind EPR is to encourage companies to design electronic equipment that can be easily repaired, packaged to reduce waste, and manufactured to contain fewer toxins; in addition, the EPR champions company responsibility for recycling and disposing of products it produces. Items cheap to disassemble, repair, and recycle will be cheaper to purchase, or will be more profitable for the company producing them.

Although the Computer TakeBack Campaign is focused mainly on domestic problems, other organizations in the United States, like BAN (2007), concern themselves with international issues:

> BAN works both domestically in the USA as well as globally with particular focus in Europe (due to strong leadership in global environmental initiatives), Asia (due to being primary victim area of toxic trade) and in the USA (due to poor record of global stewardship and their indiscriminate dumping of toxic wastes such as electronic waste and toxic ships). (online)

By working across borders, BAN is able to provide significant insight into electronic waste stream solutions. BAN is also able to call attention to the results of U.S. exportation of electronic waste to poor countries. Even in the absence of U.S. federal policy, there is

significant momentum across grassroots organizations; in fact, many of these programs could serve (and many do) as world-wide models of electronic waste prevention.

The first organization formed to tackle computer recycling in the United States is the California-based non-profit Computers & Education and Computer Recycling Corporation. Started in 1991, this corporation works with municipalities and businesses to keep electronic waste out of landfills, while providing community and after-school training programs. In 2003, they diverted 6 million pounds of computer equipment from landfills. The organization began when three individuals saw two 20,000 square foot warehouses full of slightly outdated computer equipment go to waste after schools and nonprofits were told they were available. Initially, the founders—Wil Marshman, Mark Hass, and Steven Wyatt—faced the problem of getting people to accept a "recycled" computer. Today their facility serves as a model for world-wide reuse initiatives.

Another approach to computer recycling is to, ideally, create a computer-trained community of workers by offering inexpensive computers to low-income families as well as to the schools serving those families. Per Scholas was founded in 1995 with that intent; today, in addition to plucking some 200,000 tons of electronics from the waste stream each year, Per Scholas offers vocational training to help people obtain living-wage careers. Its facilities in the South Bronx and Miami employ 50 people, and provide services to 150 organizations, including JP Morgan Chase, the IRS, and Deutsche Bank (Per Scholas, 2007). Not only does this organization provide jobs, technology training, and low-price computer equipment, but it also provides environmentally responsible recycling for end-of-life equipment.

The approaches outlined above are exemplary, but do not even scratch the surface of the grassroots movement in the United States. Other examples include iRethink, whose members recycle smaller items, like printer cartridges and cell phones, for reward points. Schools and non-profits can use iRethink for fundraising, while encouraging electronic waste reduction (iRethink, 2007; Computers & Education, 2004). Also, the Computer Reruns program, administered by New Mexico Technet, Inc., is a good example of an organization providing a computer reuse service to a large corporation—Intel, in this case—and using the service to offer computer rebuilding training to high school and college students (Computer Reruns, 2007). Once refurbished, the computers are distributed within New Mexico's school system.

RECOMMENDATIONS

Although numerous organizations and individuals in the U.S. are finding innovative ways to reduce and reuse electronic waste, all players in the recycling scheme must be diligent in researching companies and their approaches to computer recycling or disposal. Until the U.S. government, cooperating with producers and consumers, devises a system of standards for the proper disposal of electronic waste, we, as consumers, must take responsibility. As BAN (2005) warned,

> All businesses and citizens must ensure that none of their electronic waste discards are directed to the thousands of e-waste brokers and so-called recyclers now offering cheap rates and empty promises. Pains must be taken to uncover what may be false promises of "recycling or repair" and the ability to take your old computer "away." That magical place called "away" might just be a burning dump on the other side of the world. (online)

Stemming the computer waste stream starts locally, as Americans stop discarding computers and their accessories without heed and, instead, look to examples overseas as well as in their own communities. Government models—like the WEEE Directive, El-Kretsen in Sweden, and the policies a handful of American states have adopted—provide appropriate approaches that assist consumers in working together with their government representatives to reduce the

growing computer waste stream. In addition, U.S. consumers should consider supporting or joining grassroots efforts.

As educators, we should anticipate the waste stream future and request a computer recycling kit at the time of purchase (see Appendices 2 and 3 for a list of organizations and corporations that provide tools and kits). Of those mentioned here, Apple's program and Dell's Recycling Kit seem to be the most user-friendly. However, no matter the manufacturer, we must take the time to research what happens to the outdated machines that those kits help to package so nicely for recycling. At our institutions, we should look for under-funded departments or offices, and pass on a computer, printer, or keyboard when a newer model is purchased. In the event of a mass exodus of computers from any academic institution, there will always be another school that can use a ready-made lab. Even machines outfitted with discipline-specific hardware and programs can find a second (or even third) life (see Figure 4). We should use the technology we've come to know so well and get on email lists and discussion forums to set up our own virtual freecycling; sites like craigslist can help facilitate this work. University email lists can also be helpful when old computer parts pile up and need a new home. Moreover, we cannot forget the pull our institutions sometimes have in state and local government. We should encourage or, even better, become part of a coalition to lobby for stronger, safer computer and electronic waste stream recycling laws. Finally, across the United States and internationally, we must look from one government to the next to extract ideas that work and, consequently, use them to continue to build laws—such as REACH, RoHS, and, of course, WEEE—that lower the rising stream, thereby reducing the hazards a toxic flood will undeniably bring.

And, so, even though the words of this chapter have traversed across computers in our home and the labs in which we work, they end their journey on the 8-year-old desktop. Similar to its counterparts in the facility we described in our introduction, there will soon be a time when such machines will no longer be patchable. When this time comes, we, as consumers, must carefully evaluate the toxic potential of new computers and laptops on the market; by doing so, we will be following paradigms set by electronic waste reduction advocates everywhere. Even as a journey starts at the beginning, it must also find an end. At this end, we will help to begin again by performing the same level of research and care with a computer's disposal as we do with its purchase.

Figure 4. Computer parts and monitors await recycling at a collection site. Photo by Shawn Apostel.

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Appendix 1. Efforts to slow the computer waste stream in the European Union and the United States.

Europe and the Global Community			
Legislation/Effort	**Responsible Entity**	**Description**	**Date**
Basel Convention	BAN and global Community (168 countries)	Regulates post-consumer electronic waste to protect against damaging toxic trade	Late 1980s
Electronics Recyclers Pledge of True Stewardship	BAN, SVTC, Computer TakeBack Campaign	Encourages extended producer responsibility when manufacturing electronics	2002
WEEE Directive	E.U.	Regulates disposal of hazardous chemical waste; provides recycling standards for government, producers, and consumers	2003
RoHS Directive	E.U.	Limits amount of toxics producers can use in electronics	Adopted 2003; enforced 2006
REACH	E.U.	Requires manufacturers to register chemicals used in product creation	Ratified 2006; enforced 2007
State and Grass Roots efforts in the U.S.			
U.S.-based computer recycling	Computers & Education and Computer Recycling Corporation	Works with cities and businesses to divert e-waste from landfills	1991
U.S.-based computer recycling	Per Scholas	Offers inexpensive refurbished computers to low-income families and schools in their areas	1995
CRT ban	California	Regulates CRT disposal through state health and safety code hazardous waste laws	2001
eCycling partnership	A 10-state consortia, Electronicycle, and Recycle America Alliance	Work together to recycle all computers and televisions disposed of in 10 northeast states	2003

Appendix 2. Organizations that assist consumers with computer recycling.

Earth 911
https://earth911.com/recycling-guide/how-to-recycle-computers/
This well-known site offers a helpful list of links to articles, information, events, and locations about and for eCycling.

e-Stewards Responsible eCyclers
https://www.ban.org/find-recyclers
The Basal Action Network provides a list of companies that have signed the Electronic Recycler's Pledge of True Stewardship, BAN's most rigorous criteria for sustainable and socially just electronics recycling. The site also includes a state-by-state as well as international directory of these companies, including locations in Canada and South America.

Free Geek
https://www.freegeek.org/take-action/donate-technology
Any computer equipment, working or not, can be donated to Free Geek, which will repair usable computers. Free Greek promises that the computers which are not usable will be recycled responsibly. In addition, Free Geek also provides links to other eCyclers and information about eCycling.

National Technology Recycling Project
https://www.electronicsrecycling.org
The NTRP maintains a seemingly exhaustive database of computer recycling facilities in the U.S.

Plug-In to eCycling
https://www.epa.gov/recycle/electronics-donation-and-recycling
Plug-In to eCycling is a partnership between the EPA and consumer electronics manufacturers, retailers, and service providers. The program offers opportunities to donate or recycle used electronics to promote shared responsibility for safe electronics recycling.

Rethink Initiative
https://pages.ebay.com/pr/en-us/rethink/
The Rethink Initiative, hosted by eBay, brings together industry, government, and environmental organizations to confront the challenge of e-waste. The site presents information, tools, and solutions that make finding new users for idle computers and electronics easy.

"Ten tips for donating a computer: How to donate your used equipment"
http://www.techsoup.org/learningcenter/hardware/archives/page9675.cfm
A helpful resource by Jim Lynch.

TIA E-Cycling Central
http://www.eiae.org/
The Telecommunications Industry Association (TIA) is a leading trade association representing global information and communications technology (ICT) industries. The site provides links to eCycling in individual states.

Appendix 3. Corporations that assist consumers with computer recycling.

Apple, Inc.
https://www.apple.com/me/recycling/
Apple's recycling program allows customers to receive free recycling of an old computer and monitor regardless of manufacturer when they purchase a qualifying Apple computer or monitor.

Best Buy
https://www.bestbuy.com/site/services/recycling/pcmcat149900050025.c?id=pcmcat149900050025
Best Buy helps consumers dispose of the devices they use in their daily lives. In 2006 alone, more than 20 million pounds of e-waste were recycled through Best Buy programs. Best Buy stores offer free kiosks for depositing recyclables, and information on e-cycling grants, awarded to deserving communities in the United States, is available on the site.

Computer Reruns
http://www.reruns.nm.org/
New Mexico Technet's Computer Reruns has, since 1995, rebuilt computers donated by companies, organizations, and individuals, to place them in eligible schools and non-profit organizations.

Dell, Inc.
https://www.dell.com/en-us/lp/dt/dell-reconnect

When customers are ready to dispose of old PC and computer-related devices, Dell helps recycle Dell-branded products for free.

Hewlett Packard
http://www.hp.com/hpinfo/globalcitizenship/environment/return/index.html
HP offers its customers several choices—trade in, return for cash, recycle, or donate—to manage unwanted computers while simultaneously benefiting the environment.