

Waste electrical and electronic equipment (WEEE):
Creating an electronics equipment takeback program in light of current
European Union directives and possible U.S. legislation

by

Michael Pennock

A Research Paper

Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
With a Major in

Risk Control

Approved: 3 Semester Credits

Dr. Elbert Sorrell Investigation Advisor

The Graduate School
University of Wisconsin-Stout
May, 2003

The Graduate School
University of Wisconsin-Stout
Menomonie, WI 54751

ABSTRACT

	Pennock	Michael	(nmi)
(writer)	(last name)	(first name)	(initial)

Waste Electrical and Electronic Equipment (WEEE):
Creating an electronics equipment takeback program
in light of current European Union directives and possible U.S. legislation
(title)

Risk Control	Dr. Elbert Sorrell	May 2003	75 pages
(Graduate Major)	(Research Advisor)	(Month/Year)	(Pages)

Publication Manual of the American Psychological Association: Fifth Edition
(Name of Style Manual Used in this Study)

The lack of a takeback program for Waste Electrical and Electronics Equipment (WEEE) places XYZ Corporation at risk of violating European Union directives currently in effect. Legislation of electronic waste is also being proposed in various jurisdictions within the United States. The purpose of this study was to:

1. Determine what options are available to XYZ to dispose of its end-of-life electronic hardgoods in a manner that:
 - a. Maintains its industry-leading reputation as a good corporate environmental citizen
 - b. Complies with European Union directives and any other laws and regulations

2. Determine if an electronic hardgoods takeback program for Product One and Product Two can be developed in the United States prior to the enactment of laws and regulations requiring such takeback.

ACKNOWLEDGEMENTS

I would like to thank Dr. Elbert Sorrell for accepting a nontraditional student such as myself into the program and guiding my progress towards my degree.

Special thanks goes to all my fellow students in the risk control program at UW-Stout. Collaborative efforts enhanced the learning experience immeasurably. I was able to learn from all the varied life and work experiences that came with them into classroom, and non-classroom, settings. Many of these students will be among my network of professional colleagues. Some will remain friends for life.

A special acknowledgement goes to Steve Senior, my instructor in the OSHA Voluntary Compliance course. This was my first class in the program. In fact, it was my first class at the university level in over 25 years. He brought a passion to that class, and for our profession, from the first minute. He helped focus my desire to work in and contribute to the protection of worker health and safety, and environmental protection, for the rest of my working career.

TABLE OF CONTENTS

	Page number
ABSTRACT	i
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
CHAPTER 1: STATEMENT OF THE PROBLEM	1
Introduction to the study	1
Statement of the problem	6
Purpose of the study	6
Significance of the study	7
Limitations of the study	7
Definition of terms	8
CHAPTER 2: REVIEW OF LITERATURE	10
Landfills	10
Waste electrical and electronic equipment	12
Current European disposal programs	14
Impact of the WEEE directive	18
Proposed legislation in the United States	21
Waste electrical and electronic equipment at XZY Corp.	25
Summary	26
CHAPTER THREE: METHODOLOGY	27
Introduction	27

	Page number
Define	27
Measure	27
Analyze	28
Improve	28
Control	29
CHAPTER FOUR: RESULTS AND DISCUSSION	30
European Union requirements – Goal 1(b)	30
Good corporate environmental citizen – Goal 1(a)	31
U.S. takeback	32
Summary	40
CHAPTER FIVE: SUMMARY, CONCLUSIONS & RECOMMENDATIONS	42
Summary	42
Restatement of the problem	42
Methods and procedures	42
Major findings	43
Conclusions	44
Recommendations	45
REFERENCES	48
APPENDICES	
Appendix A – WEEE Directive	55
Appendix B – Composition of personal desktop computer	71

Page number

Appendix C – National recycling rates 74

Appendix D – EU member state recycling and recovery targets 75

CHAPTER ONE – Statement of the Problem

Introduction

XYZ Corporation is a major manufacturer headquartered in the United States. Among its products are electrical and electronic equipment. These items, and many others, are called hardgoods, in order to distinguish them from the chemical materials and software applications that are also manufactured and sold by XYZ. Among the hardgoods manufactured are Product 1 and Product 2. These products are manufactured in the United States and sold in North America, South America, Africa, Australia, Asia and Europe.

The European Union (EU) and its member states have concerns about the disposal of solid wastes due to limited space available for landfills. In 1999 the EU Council of Ministers adopted a rule, to be effective by 2015, to limit the amount of household waste in landfills to just 35% of the 1995 level. By 2001 restrictions on the discharge of liquid waste, explosives, corrosives, oxidizers, flammables and infectious human and animal waste will be banned. (Environment, 1999, ¶ 3) These regulations are designed to encourage incineration of wastes in order to reduce volumes.

The generation of waste electrical and electronic equipment (weee) has been noted as an increasing category of waste. The British Environmental Information Exchange reported that Europe generated 6 million tons of such waste in 1998. Only 10% of this quantity was reused instead of being discarded. The content of the electrical waste included 3.6 million tons of metal, 1.2 million tons of plastic, 27,000 tons of lead, and eight tons of mercury. (Background Facts, 2002, ¶ 1)

Personal computers are one of the biggest single sources in the weee category. The lifespan of a computer is only two to three years before it becomes obsolete. Mike Thompson, a U.S. Congressman from California and author of a 2002 electronics-recycling bill that did not become enacted. His bill has been reintroduced in 2003. He reports, “500 million computers will need to be disposed of by 2007.” Further, “80% of the e-waste is actually exported to Asia, where it ends up in riverbeds or is illegally and improperly disposed.” (Bell, 2002, ¶ 2)

In the United States, ten states have seen electronic waste legislation proposed: California, Hawaii, Massachusetts, Minnesota, Nebraska, New York, New Jersey, North Carolina, Oregon, and South Carolina. According to Californians Against Waste (California Recycles, n.d., E-Waste/E-Waste: Policy & Legislation/Other State’s E-Waste Legislation, Table, 2003 E-Waste Legislation in other States), regulated items include cathode ray tubes (CRTs), computers, and electronic products (defined in Minnesota as computer monitors, laptop computers, televisions, central processing units, and printers; unspecified in Nebraska and New Jersey; equipment identified as “hazardous” in New York). Local jurisdictions are also preparing to legislate. On 13 February 2003, two Los Angeles, California, city councilmen announced plans to mandate retailers accept the return of waste electronics in the city. (California Recycles, n.d., E-Waste/E-Waste: Policy & Legislation/California Local Governments Respond to E-Waste, Cities and Counties That Have Adopted Resolutions, #13, City of Los Angeles) As of yet, none of the legislation has been enacted.

As Rep. Thompson notes, it is thought that up to 80% of electronic waste is shipped to Asia for disposal. The Basal Action Network has a post on its web site

entitled “Ghosts in the Machines.” Author Sherry Lee describes an illegal e-waste industry in the town of Guiyu in China’s Jiangxi Province. A million tons of e-waste is collected annually, bringing in Renminbi (yuan) 1 billion, or about U.S.\$121 million. (Lee, 2002, ¶ 5) Workers heat printed circuit boards over charcoal fires to melt and collect the lead. Toner cartridges are pried open and residual toner is collected. Wire insulation is burned in order to access the copper. The result is pollution to the extent that drinking water must be imported from 15 km distance. No official medical monitoring has taken place, but local doctors report an incident of miscarriages above the national average. (Lee, 2002, ¶ 6)

The *San Jose Mercury-News* ran a three-part follow-up report on Guiyu that was printed in November of 2002. Reporter Karl Schoenberger sighted products from HP, IBM and K-Mart, with identification tags from San Francisco State University, the Los Angeles Unified School District, Xerox Corp., and the U.S. Defense Intelligence Agency. The reporter also collected water samples. (Schoenberger, November 23, ¶ 1) Analysis showed lead at 190-times the limit set by the World Health Organization. There were also “sky-high levels of lead, zinc and chromium in one of two sediment samples.” (Schoenberger, November 23, ¶ 5) The American Conference of Governmental Industrial Hygienists’ *2003 Threshold Limit Values for Chemical Substances and Physical Agents* notes that lead has “critical effects” on the central nervous system, blood, kidneys and reproductive system. Chromium’s effects are noted on the dermas, liver, kidney, respiratory tract, and is carcinogenic in certain forms.

Workers, who are reported by the *Mercury News* to make 17 U.S. cents per hour, do the work. They have no personal protective equipment. They work on the 50-80% of

the e-waste collected in the U.S. for recycling that is actually shipped overseas. The U.S. Environmental Protection Agency is cited in the *Mercury News* article as having reported in 1999 “that only 18% of all discarded computers were being recycled.” China is the largest buyer.

The world is beginning to see regulations put in place to control this situation. The European Union’s (EU) directive on Waste Electrical and Electronic Equipment (WEEE) acquired the force of law on 13 February 2003 with its publication in the EU’s official journal. It has been under consideration since 30 July 1996. The objectives of the directive are to:

... protect soil, water and air from pollution caused by current management of WEEE, to avoid the generation of waste, which has to be disposed of and to reduce the harmfulness of WEEE. It seeks to preserve valuable resources, in particular energy. Another objective of the proposed Directive is the harmonisation of national measures on the management of WEEE. (Waste Electrical and Electronic Equipment Directive, 2003, p. 6)

The directive’s main objective is to prevent the production of waste by encouraging design changes in the development of electrical and electronic equipment. A companion directive, Electrical and Electronic Equipment (EEE), is under consideration. This directive would mandate use of “Design for Environment” (DfE) principles in product design. (Electrical and Electronic Equipment Directive, 2003, pp. 14-15) One section of the originally proposed WEE directive was separated out and made into its own directive. This is the Restriction of Hazardous Substances (RoHS). This directive calls for a ban on the use of lead, mercury, cadmium, hexavalent

chromium, and PBDE and PBB flame retardants (used in plastics manufacture), with limited exceptions, in all products, including electrical and electronic equipment.

(Restriction of Hazardous Substances Directive, 2003, p. 1)

The WEE and RoHS directives have a series of action deadlines.

1. 13 August 2004, each member state must have national laws that direct the implementation of these two directives.
2. 13 February 2005 is when the European Commission will review suggestions for amendments, based on technical and scientific progress.
3. 13 August 2005, each member state must have a program in place to have free takeback of waste goods and to ensure that equipment manufacturers are responsible for financing the collection, treatment, recovery and disposal of all such waste.
4. 1 July 2006 is the latest date to ban the substances specified in the RoHS directive. Member states may implement national bans at an earlier date.
5. 31 December 2006, each member state must have achieved an average waste collection of four kilograms per inhabitant annually.
6. 31 December 2008 is the deadline for revised collection, recycling and recovery targets to be established by the EU.

Finally, the EU passed a companion declaration stating it would “act expeditiously” to change laws if German fears concerning adverse financial accounting procedures would be required by WEEE.

Statement of the problem

XYZ's Division 1 sells Product 1 and Product 2. These are hardgoods that, at end-of-life, are classified by the WEEE directive as electrical and electronic waste in the member states of the European Union. Over the last three decades, sales have amounted to over 30,000 units worldwide. These are long-lived products, with some 30-year old units still performing satisfactorily. Current sales are some 2,000-3,000 units per year. About 40 percent of past and current sales are European. A similar percentage of sales have been in the U.S. The WEEE directive means that XYZ is responsible for the disposition of all existing units, as well as future units.

XYZ currently has no plan for dealing with the WEEE takeback requirement in Europe. A group of corporate and European managers and staff personnel is looking at the problem. There is no group addressing the takeback issue in the United States. XYZ currently has a program to takeback two models of Product 1 from customers who upgrade their units. The purpose of the current program is to access replacement parts that are no longer manufactured to service existing units in the field. There is no general program for takeback of weee from Division 1 or any other division of XYZ Corporation.

Purpose of the Study

The purpose of this study is to:

3. Determine what options are available to XYZ to dispose of its end-of-life electronic hardgoods in a manner that:
 - a. Maintains its industry-leading reputation as a good corporate environmental citizen

- b. Complies with European Union directives and any other laws and regulations
4. Determine if an electronic hardgoods takeback program for Product One and Product Two can be developed in the United States prior to the enactment of laws and regulations requiring such takeback.

Significance of the Study

The results of this study will determine if Division 1 actually puts a takeback program into place. This can then be used as a model to expand the takeback program to include more of Division 1's other hardgoods. Division 1's takeback program can then serve as a model to be followed by XYZ Corporation as a whole. It can also be analyzed to see if any lessons are applicable to the takeback issue in Europe as regulated by the WEEE directive.

Other professionals will be able to use the results of this study to help guide the creation of takeback programs in their own organizations. This will be an environmental benefit to everyone. It may also serve as a model to guide the creation of legislation mandating hardgoods takeback. XYZ, and manufacturers as a whole, desire a single regulation over a patchwork of differing local regulations that would make full compliance difficult.

Limitations of the Study

This study is limited to two products produced by Division 1 of XYZ Corporation. It does not include other hardgoods manufactured and sold by Division 1. It does not include other hardgoods manufactured by other divisions of XYZ. It may be

that the number of units involved is insufficient to generate economies of scale to the extent that this service business can be made to break-even or to profit.

Definition of terms

Hardgoods – Any physical item, either a finished product or an intermediate product. As distinguished from a chemical element, mixture or compound, and computer software intellectual property.

weee – Waste Electrical and Electronic Equipment. Defined by the European Union directive as a hardgood belonging to one of ten categories: large household appliance; small household appliances; IT (information technology) and telecommunications equipment; consumer equipment; lighting equipment; electrical and electronic tools (with the exception of large-scale stationary industrial tools); toys, leisure and sports equipment; medical devices (with the exception of all implanted and infected products); monitoring and control instruments; and automatic dispensers. Used in lower case, it is a descriptive term.

WEEE directive – European Union directive which has the force of law on member states, formally titled “Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment.” Used in upper case, it refers to this particular EU directive.

Product 1 and Product 2 – Products of the XYZ Corporation that are categorized by WEEE as monitoring and control equipment.

RoHS – Restriction of Hazardous Substances. This directive calls for a ban on the use of lead mercury, cadmium, hexavalent chromium and PBDE and PBB flame retardants

(used in plastics manufacture), with limited exceptions, in all products, including electrical and electronic equipment.

RoHS directive – European Union directive which has the force of law on member states, formally titled “Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.”

Takeback – A program by which a manufacturer of electrical and/or electronic equipment takes back end-of-life equipment for disposal. May or may not involve a fee charged to the owner of the equipment.

Six Sigma – A process management tool designed to reduce variability in output, improve process control, improve quality, and reduce defects. Various Six Sigma terms used in this paper are defined below.

X – A process input variable, associated with sources of variation

Y – A process output variable or a customer requirement

Project Y – The ultimate output goal of the project

CHAPTER TWO – Review of Literature

This chapter will review the problem posed by the perceived shortage of landfill space in Europe; the contribution waste electrical and electronic equipment (weee) has on landfills; programs currently in place to reduce weee land filling through recycling; weee recycling programs in Europe; the perceived impact of the WEEE directive; legislation proposed in the United States; and current weee disposal practices at XYZ Corp.

Landfills

The European Union (EU) is an organization of the United Kingdom, Ireland, France, Spain, Portugal, Luxembourg, Belgium, the Netherlands, Germany, Finland, Sweden, Austria, Italy, Greece, and Denmark. These countries are the “member states.” Certain actions taken by the European Union Parliament take the effect of laws for each country. These are known as “directives.” Another ten Eastern European nations, plus Turkey, are attempting to gain membership in the EU. Once admitted, these nations will be required to follow the enacted European Union directives.

Among the issues of concern to the EU is the physical environment. This paper deals with the land environment, and only tangentially on air and water insofar as they intersect with land issues. The primary issue is the absolute quantity of waste generated in the EU. Current generation is 1.3 billion tons annually, with agriculture contributing another 260 million tons. Of this total, 40 million tons are considered hazardous. Two-thirds of this mass is either land filled or incinerated. (Waste, 2003, ¶ 1) This same report from the Office of Economic Cooperation and Development estimates an increase in waste generation between 1995 and 2020 of 45%. (Waste, 2003, ¶ 3) The EU Commission has estimated there is a mean of ten-years capacity left in European

landfills, though that figure varies from only two years in Luxembourg to about 50 years in Finland. (Waste Generation and Management, n.d, p. 223) Current recycling rates for all waste in selected EU member states, the U.S., Canada, and Norway, including weee, and targets for a few countries, are in Appendix Three.

Waste grew 10% between 1990-95 while economic activity only grew 6.5%. Part of the reason is that concern for, and treatment of, air and water increased the amount of sewage sludge and flue gases residue. The size of the problem can be illustrated by its impact on the transportation system. For example, 15% of the total weight of freight in France is waste. (Waste Generation and Management, n.d., p. 203)

The final resting spot for waste in landfills varies between countries. In Northern Europe, landfills receive about half the total waste produced. But in poorer countries such as Greece, Spain, and Eastern Europe, the big majority of waste is landfilled. (Municipal Solid Waste Management, 2002, ¶ 1) Pressure to reduce waste generation may be seen in the tip fees charged to dump solid waste in European landfills.

A tip fee is what a waste hauler is charged for permission to dump into the landfill. Across Europe this fee ranges from U.S.\$80-300 per metric ton (2,200 pounds). This compares to U.S.\$10-70 per short ton (2,000 pounds) in the United States. This reflects the fact that the United States has more open land area than Europe in which to locate landfills. The European tip fees are an administrative effort to encourage waste producers to find alternatives to landfills. One measure of the effectiveness of efforts to reduce landfilling is that Europe currently generates only one-half the solid waste generated in the United States, per capita. (Raymond, 2002, p. 1) The EU has codified the effort to reduce dependence on landfills. A directive mandates that by 2015, the

tonnage household waste going to landfills will only be 35% of the amount landfilled in 1995. (Environment, 1999, ¶ 4)

The EU has a “Community Strategy for Waste Management.” The Commission of the European Union, the central executive body of the EU, on 30 July 1996, presented it. “The review establishes as the general objective of the community waste management policy the need to ensure a high degree of environmental protection without distorting the function of the internal market with a view to promoting sustainable development.” (Community Strategy for Waste Management, 1996, ¶ 1) It prioritizes the prevention of waste, followed by recovery, with final disposal as the last alternative. Problems associated with final disposal in landfill include possible pollution of water due to leaching, greenhouse gas increases from methane emissions, and loss of otherwise usable land. Current methane capture from landfills using maximum achievable technology is only 45%. (Community Strategy for Waste Management, 1996, ¶ 5)

Waste Electrical and Electronic Equipment

Waste electrical and electronic equipment is of special concern in Europe because it is both hazardous and it is a fast-growing segment of the waste stream. Computer equipment is the most visible portion of weee waste. In 1998 Europe disposed of 6 million tons of weee. (*Environmental Information Exchange, Background Facts*, ¶ 1) This was about 4% of the total waste stream. By 2010 it is estimated that it will double to 12 million tons. (Churchman-Davies, 2002)

A significant reason the waste trend is increasing is due to technological obsolescence. This is a result of the pace of development of both computer hardware and software. The U.S. Environmental Protection Agency (EPA) has noted that over the past

twenty years, the price of hardware has halved every two years while speed and memory has doubled. (Moore's Law, n.d., ¶ 1) The computer industry has had such consistent experience with this halving/doubling phenomenon that they have dubbed it "Moore's Law." The average computer now has a lifespan of only two years before it becomes technologically obsolete. XYZ Corp., for example, leases all its computers and upgrades each one every two years. As recently as 1994, computer lifespan in general business and industry was four to six years. (Wood, 2001, ¶ 3)

Electrical and electronic waste is also very hazardous. Europe's 1998 weee included 27,000 tons of lead and 8 tons of mercury. (Background Facts, 2002, ¶ 1) The typical 60-pound desktop computer and monitor includes antimony, arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel, among other metals, all of which are toxic to humans. [See Appendix Two for a complete table] Machines that are deposited in a landfill can leach these metals into surface and ground water. Their dust can also spread during any mechanical crushing or deposition into the site. Proper disposal of weee is, therefore, both a landfill and a public health problem.

One response to these hazards is the Restriction of Hazardous Substances directive of the European Union. It began as an integral part of the WEEE directive, but was separated out. One of the substances that will be affected is lead. This will have a big impact on electrical and electronic equipment because current solder mixtures are generally 70% lead. The proposed lead content in solder will be 0.4% by weight, none of which may be intentionally added (except for lead in solder). (Restriction of Hazardous Substances Directive, 2003, Annex, #6 & 7))

Industry groups and equipment producers are beginning to find solder substitutes. Microchip manufacturer Intel has developed a tin/silver/copper alloy as the replacement for tin/lead solder used in surface mount technology (SMT) components. The U.S. association IPC brings together companies in the electronic interconnection industry. Its web site sponsors an industry-wide “nolead forum” for information exchange. The mission statement of the Soldertec web site summarizes the cooperative spirit that permeates the drive to replace lead in solder:

The prime objective is to build a global network of industry contacts within which the technology development and transfer can be facilitated as a virtual community for lead-free soldering. This will be achieved through meetings, internet discussion forums, newsletters and several free services. (SOLDERTEC, n.d., ¶ 3)

There have been attempts to reuse old computers and thus avoid the disposal problem. However, given the obsolescence problem, this is becoming more difficult. In 1999, only 6% of computers were recycled, and another 8% donated to subsequent users. By 2004, there will be some 315 million obsolete computers just in the U.S., and a comparable number in Europe, about 75% of them in storage awaiting proper disposal. By 2005 there will be one computer becoming obsolete for each new computer entering the market. (Thorpe, 1999, ¶ 5) Thus the quantity, the inability to reuse significant numbers of machines, and the toxicity of old computers has led to a search for alternative solutions.

Current European disposal programs

The most common disposal solution today is to either warehouse obsolete equipment, or ship it to another country. The National Safety Council, cited in a

Washington Post article, estimates that 80% of the computers collected by recyclers end up in Asia. (Goodman, 2003, ¶ 4) The Basal Action Network, a nongovernmental environmental activist group, has a post on its web site entitled “Ghosts in the Machines.” They reprint a story from the *South China Morning Post Magazine* of 12 May 2002. Author Sherry Lee describes illegal e-waste processing in the town of Guiyu in China’s Jiangxi Province.

A million tons of e-waste is collected annually, bringing in Renminbi (yuan) 1 billion, or about U.S.\$121 million. (Lee, 2002, ¶ 5) Workers heat printed circuit boards over charcoal fires to melt and collect the lead. Toner cartridges are pried open and residual toner is collected. Wire insulation is burned in order to access the copper. The result is pollution to the extent that drinking water must be imported from 15 km distance. No official medical monitoring has taken place, but local doctors report an incident of miscarriages above the national average. (Lee, 2002, ¶ 6)

In November 2002 the *San Jose (California) Mercury-News* ran a three-part follow-up report on Guiyu. Reporter Karl Schoenberger saw products from HP, IBM and K-Mart, with identification tags from San Francisco State University, the Los Angeles Unified School District, Xerox Corp., and the U.S. Defense Intelligence Agency. (Schoenberger, November 23, 2002, ¶ 1) The reporter also collected water samples. Analysis showed lead at 190-times the limit set by the World Health Organization. There were also “sky-high levels of lead, zinc and chromium in one of two sediment samples.” (Schoenberger, November 23, 2002, ¶ 5) The American Conference of Governmental Industrial Hygienists’ *2003 Threshold Limit Values for Chemical Substances and Physical Agents* notes that lead has “critical effects” on the central nervous system,

blood, kidneys and reproductive system. Chromium's effects are noted on the dermas, liver, kidney, respiratory tract, and is carcinogenic in certain forms.

Workers, who are reported by the *Mercury News* to make 17 U.S. cents per hour, do the work. They have no personal protective equipment. They work on the 50-80% of the e-waste collected in the U.S. for recycling that is actually shipped overseas. The U.S. Environmental Protection Agency is cited in the *Mercury News* article as having reported in 1999 "that only 18% of all discarded computers were being recycled." China is the largest buyer.

The Chinese government banned the importation of such e-waste following the publication of such articles in the press. A feature story in the 24 February 2003 *Washington Post* reported on an investigation of the current situation in Guiyu. Twenty-two shipping containers full of e-waste were seized in the port of Wenzhou, the traditional port of entry for these items. However, business in Guiyu continues unabated as new ports are utilized and customs inspectors are bribed to permit the importation of e-waste. (Goodman, 2003, ¶ 16)

A new dumping ground in Thailand. The Nation magazine reported that in February 2003, 100 shipping containers were at the port of Bangkok with no registered owners. Thai law says that any container unclaimed over sixty days becomes government property, and government responsibility. E-waste exporters have established sham corporations in Thailand as the ostensible owners of the e-waste. Once the material is in port, they only have to wait the 60 days and the material becomes the government's. Thus responsibility for the waste shifts from the previous ostensible owners to the Thai government. (Hertsgaard, 2003, ¶ 7)

One of the principles of the EU's directive on weee is that the Union should treat its own e-waste. The WEEE directive establishes a timeline for implementation of this goal. Each member state must have a weee takeback program in place no later than 13 August 2005. They may also implement a program at an earlier date, and a number of European countries already have weee recycle efforts in place. In 1995 Norway, not a member state of the EU, became the first country to have a weee return system in place. In 2000 it collected 144,000 tons of weee, 27% of that year's weee waste stream. However, the Norwegian system is capable of collecting 100% of weee waste. It is in place and available for utilization as the collection rate of weee increases in that country. (Lamvik, Myklebust and Miljeteig, 2002, ¶ 3)

The Norwegian system is based on the AEOLOS (An End-Of-Life Of Product Service) methodology. AEOLOS has three main components: disassembly, design, and tracability. Disassembly means a product must be able to be disassembled easily, quickly, and economically. Design involves initial product development with an eye towards end-of-life (e-o-l) considerations. Tracability means that a product in the disposal stage can be traced and accounted for. This is to prevent "free riders," companies who put products on the market without consideration of financing its own e-o-l. The preferred AEOLOS hierarchy for e-o-l is: remanufacturing; parts remanufacturing; material recycling; incineration with energy recovery; incineration without energy recovery; and landfill as a last resort. AEOLOS has been adopted by the Commission of the European Union as a guiding methodology for weee e-o-l. (Lamvik, Myklebust and Miljeteig, 2002, ¶ 2)

Belgium has a program called RECUPEL. It has been in effect since 1 July 2001. A consumer who replaces one item for another, a new washer, for example, may elect to have the retailer takeback the old item. Or the consumer may take the old item to a “container park.” In any case, the consumer must pay a premium on any and all new electrical and electronic products purchased after the RECUPEL effective date. (RECUPEL, 2003, Secs. 2 & 4)

Denmark identifies itself as one of the prime originators of the WEEE directive, and had a national law in place in 1998. The country produces about 103,000 tons of weee annually. 8,000 tons are fully treated as hazardous waste, 35,000 tons are recycled, and 60,000 tons are discarded. By 2008 it is expected that 20,000 tons, 20% of weee, will be fully treated as hazardous waste. The biggest change in the current system is that with the adoption of the EU WEEE directive the revenue to cover the cost of the program will shift from its current source, local governments, onto the producers of electrical and electronic equipment. (Electronics: International Initiatives, n.d., Denmark section)

Impact of the WEEE Directive

Reaction to the WEEE directive from environmental groups can be described as favorable, with reservations. A position paper from Computer Professionals for Social Responsibility, issued after WEEE adoption in February 2003, is typical. “The CPSR/WGCE (Working Group on Computing and the Environment) supports the WEEE and the principle of increased producer responsibility for the disposal of electronic goods on which it is based.” (Position Paper, n.d., Sec. 4) One of the most common complaints from environmentalists has been the directive’s long gestation. Ted Smith of the Silicon

Valley Toxics Coalition said in an interview on 25 April 2002, “In Europe, the WEEE ... Directive just seems to be dragging on endlessly.” (Gordon, 2003, streaming audio)

Mike Childs of Friends of the Earth called WEEE “innovative, far-reaching and likely to prompt a tectonic shift in recycling culture.” In this 30 November 2002 interview, he went on to say, however, “This being European legislation, however, it is also dense, vague and brain-crushingly dull for anyone not involved with or avidly interested in the fate of electronic waste. Even then, it's a stretch. The directive is long-winded, bureaucratic and time-consuming.” (Shabi, 2002, ¶ 9)

Environmental groups especially support the WEEE requirement that producers bear the cost of takeback. Bellona, a prominent European environmental group, “congratulated the European Parliament for having played a crucial role in ensuring that the 'polluter pays' principle has now been anchored in a European environmental legislation.” It helped to rally support for this position, promoted by the European Parliament. This was opposed by of the European Commission (the EU's executive body) that favored a consumer-pays approach. The producer-pay scheme was adopted. (Haugsten, 2002, ¶ 3)

Industry reaction has been to attempt to influence the direction of various subparts of the directive. This was true prior to adoption and is also the case now, as the period for suggested amendments extends until 13 February 2005. A joint industry press statement in 2002 argued against the requirement that current producers be responsible for the takeback of all existing products, even those manufactured by a company no longer in business (orphans). They fear this “would ... become a dangerous incentive for free-riding, meaning short-sighted actors (producers = importer and/or manufacturer)

would be able to place products on the market without addressing how these products should be recycled in the future.” (Joint Press Statement, n.d., ¶ 5)

Eurochamber, the Europe-wide Chamber of Commerce representing the business sector, campaigned against takeback for existing equipment. “We reject an obligation to take back WEEE without a new product being supplied.” They also expressed concern about the free-rider issue. Another major point is how collection is to take place. WEEE mandates separate collection of household goods at the curbside of the home. This is to encourage higher participation than would be the case if the homeowner had to transport the item to a central collection point. Eurochamber feared this would increase costs. (Eurochambres, n.d., ¶ 1)

Industry’s reaction has also been based on difficulties experienced as member states recycled weee prior to the directive’s enactment. The most notorious has been Britain’s experience with refrigerators and freezers. Britain has a very low level of recycling as a whole (see Appendix Three). Yet it has already achieved the WEEE minimum recycling goal of 4 kilograms of weee collected per inhabitant per year. (WEEE Targets, n.d., ¶ 6) This is a result of mandatory recycling of refrigerators and freezers, which, along with items such as washer and dryers, constitute what is called “white goods.” Fridge collection began in order to remove foam insulation, which contains ozone-depleting chemicals (ODCs), from the units. The reduction of ODCs is the subject of another EU directive.

However, no facility was in place to do the recycling, so the units piled up, about 2.5 million units per year for two years. This has cost local units of government between £75-100 million. (Goosey, ¶ 2) British Prime Minister Anthony Blair referred to this as a

“multi-million pound fiasco” in January 2002. (UK Fridge Fiasco, 2002, ¶ 1) Adrian Harding of the government’s Environment Agency said, “Fridges are just one tiny part of the WEEE directive – if we think we have problems now then we ain’t seen nothing yet. We need to learn from this and have a slightly better run in to the future legislation.” (Fridge Recycling, n.d., ¶ 3)

Proposed legislation in the United States

There is currently no national legislation that addresses the issue of weee. The only effort to pass such legislation, Rep. Mike Thompson’s previously cited bill, was not enacted. Thompson reintroduced the bill on 7 March 2003. Given the absence of Federal regulation, a number of alternatives are being tried: state laws; local laws; voluntary takeback initiated by individual manufacturers of electrical and electronic equipment; and voluntary takeback initiated by consortiums of manufacturers of electrical and electronic equipment, governments, and consumer/environmental organizations.

Californian’s Against Waste provides a very thorough Internet web site that summarizes state initiatives for the 2002-2003 legislative season. It lists twenty-one states that have introduced twenty-nine pieces of e-waste legislation. This is an increase from ten states and thirteen proposals in the 2001-2002 legislative sessions. To date (26 April 2003) only one proposal has been passed and signed into law. Virginia now has a local-option law that permits any locality to ban the disposal of cathode ray tubes (CRTs) in private landfills. All twenty-eight other bills are either in committee, been withdrawn by their sponsor, or have lost in legislative voting. ((California Recycles, n.d., E-Waste/E-Waste: Policy & Legislation/Other State’s E-Waste Legislation, Table, 2003 E-Waste Legislation in other States) Legislation passed in previous years includes a total

ban on landfill disposal of CRTs in California and Massachusetts, and partial bans in New Hampshire and Wisconsin. (Dude, 2002, p. 7)

The largest locality to pass e-waste regulation has been the City of Los Angeles, California. It is a program contracted to Nxtcycle Corp. to conduct a “comprehensive residential e-waste recovery program.” It does not include business, industry, or governmental bodies. An as yet undefined number of permanent drop-off locations will be established in the city. Nxtcycle will also conduct an unspecified number of one-day collection events in neighborhoods distant from the permanent drop-off sites. (Nxtcycle, 2003, ¶ 1) The LA city council is also considering a local ordinance that would require retailers to accept old televisions and computer monitors for reuse/recycling. (Garza, 2003, ¶ 1)

Many individual manufacturers have e-waste programs in the United States. Apple, Dell, Gateway, HP, IBM, Panasonic, Phillips, Sharp, Sony, and Xerox are manufacturers of electrical and electronic equipment that either use Design for Environment principles to make items easier to dismantle and recycle, will take back their products, or provide a rebate on a new product if the old product was recycled by the consumer. (Electronics: Industry initiatives, 2002, p. 1) Business groups have praised such efforts. A Competitive Enterprise Institute and Reason Public Policy Institute study says that four million pounds (2,000 tons) of e-waste is sent to manufacturers’ recycling plants each month. The report favors voluntary efforts over government-mandated programs such as WEEE. (Gattuso, 2002, ¶ 9)

Some environmental groups are working to expand voluntary industry initiatives. As You Sow, a group that encourages corporate social responsibility, is working with

five computer makers - Apple Computer, Dell Computer Corp., Gateway Inc., Hewlett-Packard Co., and IBM - to urge them to adopt concrete goals for computer recycling. (Computer take back and recycling/Computer recycling, n.d. p. 1) On 9 April 2003 Dell became the first company to agree to set a specific computer-recycling goal and to make that goal public. Conrad McKarren of As You Sow hopes that within six months Apple, HP, and IBM will also have adopted and announced goals. (Gordon, 2003, streaming audio)

Other environmental groups, however, are very skeptical of voluntary industry-based recycling programs. Robin Schneider of the Texas Campaign for the Environment says that IBM's program "collected less than 1000 machines in a year's time - less the 0.03% of their annual [machine unit] sales." (R. Schneider, personal email, March 5, 2003) David Wood of the Computer TakeBack Campaign says that Dell offers "European consumers a free, convenient service to recycle consumer electronics. Although electronics manufacturers comply with these cleaner standards in Europe, environmentally responsible reform in the U.S. hasn't been," in a parody of Dell's advertising slogan, "as 'Easy as Dell.'" The organization asserts that the effort will "never recover more than a tiny fraction of the millions and millions of machines [Dell] sells every year." (Computer TakeBack Campaign, 2003, ¶ 4)

In spite of the lack of Federal legislation, the U.S. Environmental Protection Agency is involved in e-waste recycling through the National Electronics Product Stewardship Initiative (NEPSI). It was founded in June 2001. The membership is divided fairly evenly among electronics producers, governmental groups (including the Minnesota Office of Environmental Assistance), and a third group consisting of retailers,

recyclers and environmentalists. (NEPSI homepage, n.d., ¶ 2) The group's main goal is “the development of a system, which includes a viable financing mechanism, to maximize the collection, reuse, and recycling of used electronics, while considering appropriate incentives to design products that facilitate source reduction, reuse and recycling; reduce toxicity; and increase recycled content.” They say this effort will require Federal legislation. (NEPSI, n.d., ¶ 4)

NEPSI's most significant achievement to date has been its March 2002 proposal to establish an e-waste financing system. The principle is an unspecified “front-end” charge to purchasers of electronic equipment. NEPSI has a goal of developing an action plan to implement a weee-recycling program on a national level, including: making the system convenient for consumers; how to promote better product design to facilitate end-of-life disposal; and how to share costs between producers, governments, and consumers. NEPSI's goal is to present a final report some time in 2003. (NEPSI dialog achieves milestone, 2003, p. 1)

Some environmental groups have expressed skepticism concerning NEPSI's efforts. David Woods of GrassRoots Recycling Network said the financing concept was significant, but that this was just an agreement to work towards a final agreement. He said the “specter of a patchwork of legislation” at the state level is driving NEPSI's goal to see a national solution. Michael Bender of the Mercury Policy Project called the financing agreement “significant ... but we are a long way from popping the corks” in celebration of achieving a final goal. Mark Murray of Californians Against Waste also expressed support for a front-end financing system, but said environmental groups should continue to work at the state and local levels. (4th annual computer report, 2003, ¶ 3)

Waste electrical and electronic waste at XYZ Corp.

XYZ Corp. is not a member of NEPSI and has no centralized e-waste take back program. However, all personal computers in the Corp. are leased and returned to the vendor every two years as upgraded models are put in place. CRTs are also leased, but they are returned less frequently. Like many corporations, XYZ has a reverse supply chain organization that deals with the disposition of many end-of-life items ranging from office furniture to chemicals. They have some experience with various electronic recyclers as well.

Division One management in the United States is working with Corporate and Division One management in Europe to develop a plan to comply with the WEEE directive in Europe. One resource they use is the one person in the corporation who is assigned to maintain knowledge and awareness of ongoing developments with the WEEE and RoHS directives. Other than this one individual, there is no public information of XYZ e-waste recycling efforts, nor is there any visible internal information. It was only through a literature review that it was learned that Division Two had, at one time, an e-waste recycling program for one of its products. They accepted their product for take back, as well as any similar product from competitors. This expansion of the take back effort was designed to give the selected recycling vendor a sufficient quantity of units to make its participation economically viable.

Division One management did not initiate the effort to create a take back program for Product One and Product Two. Two division staff members who work in the area of product stewardship began the effort. One of the major concerns has been to find a vendor who will accept Product One and Product Two. The vendor must be willing to

abide by XYZ's corporate commitment to environmental responsibility. Division One management has also decided that the take back effort must either be a profit center for the Division, or at least a break-even venture.

Summary

The literature review examined the weee problem in Europe, the United States, and at XYZ Corp. Current disposal solutions were examined. These include exporting large amounts of the waste to poor countries with virtually no environmental or worker health regulations, large quantities warehoused awaiting final disposition, disposal into existing landfills or incineration as nonhazardous waste, very limited recycling for reuse, and even less recycling as hazardous waste. The review demonstrates that the quantity of the waste and its toxic nature has promoted governmental action on both sides of the Atlantic Ocean. This has included both efforts to restrict the toxic content of the hardgoods, especially lead, and efforts to promote complete recycling. However, the scope of legislation, both enacted and proposed, varies greatly. Reaction to governmental regulation of weee is essentially divided, pro and con, between environmental groups and the industrial producers of electrical and electronic equipment. It appears that both sides agree that governmental regulation of e-waste is inevitable in the current political climate, and that the argument has shifted to the details such regulation will take.

CHAPTER THREE - Methodology

Introduction

The methodology used in this study is Six Sigma. Six Sigma is a process management tool designed to reduce variability in output, improve process control, improve quality, and reduce defects. (Sigma) This is the corporate choice of XYZ Corp. Six Sigma follows the DMAIC model – **D**efine, **M**easure, **A**nalyze, **I**mprove, and **C**ontrol. Each phase of the project will be defined below and related to the weee project tasks.

Define

The first task in definition is to establish the scope and boundaries of the project. Persons who are experienced in Six Sigma methodology caution against taking on too big a task, or “trying to boil the ocean.” Scope in this project was limited to Product One and Product Two. Other products in the division, and other products in other divisions in the corporation, are outside the boundaries of this project.

The second task in definition is to allocate initial resources. In this case two staff persons were assigned as “Green Belts.” A Green Belt is someone who has taken a forty-hour training course in Six Sigma methodology and who has primary responsibility for the project. A Black Belt, a person who works on Six Sigma projects full time, was assigned to the project on an on-call basis. Various subject matter experts were identified who can be called upon for expertise.

Measure

The primary measurement tool is the process map. This map describes the major activities and tasks that are currently taking place. In the case of e-waste, the project

mapped a current program to recycle Product Three and Product Four on a very limited basis. These machines are being taken in trade for new equipment, shipped to the manufacturing plant, and stripped of certain parts that are no longer made and will be used as spare parts for existing machines. The process map identifies all the steps required to get the machines from the customers, back to the plant, and what happens to the rest of the machine after the spares are stripped.

The major tool used in this analysis is the cause-and-effect (C&E) matrix. Key input variables are identified. These are actions that must take place in order to ensure success. Each action is given a numerical weight, established by the team. Key output variables are also identified. These are the results the project needs to achieve. The expectation is that the C&E matrix will help identify both positive and negative lessons to be learned from current practices.

Analyze

Failure Mode and Effects Analysis (FMEA) is the primary Six Sigma analytical tool. It will be used by the e-waste Green Belt team to identify shortcomings in the current process. It will also help identify potential improvements that can be used in the Product One and Product Two take back project. FMEA will help prioritize tasks so that those with the most significant impact on the success of the project can be identified. These tasks will get proportionately greater resources than lower priority tasks.

Improve

Design of Experiments (DoE) is the backbone of the improvement phase. Once the take back project begins, experiments will be conducted to see if the process can be improved. Some planned experiments will be designed to test different recycling

vendors, transportation alternatives from the customer to the recycling vendor, and improved communication between XYZ and potential recyclers of Product One and Product Two. Each experiment will be done independently so its effect on the outcome of the project can be most clear.

Control

The e-waste project will conclude with a control plan. This plan is intended to institutionalize the results of the project. Six Sigma is structured to ensure the lessons of the project are retained and continue to be implemented long after the initial DMAIC study concludes. The control plan requires documented procedures, work instructions, record keeping, and auditing. This will make sure the gains are not lost if certain individuals leave the scope of the project. Those taking their place will have procedures to follow, and an audit requirement to make sure the procedures are being followed.

CHAPTER FOUR – Results and Discussion

The purpose of this study was to:

1. Determine what options are available to XYZ Corp. to dispose of its end-of-life electronic hardgoods in a manner that:
 - a. Maintains its industry-leading reputation as a good corporate environmental citizen
 - b. Complies with European Union directives and any other laws and regulations
2. Determine if an electronic hardgoods takeback program for Product One and Product Two can be developed in the United States prior to the enactment of laws and regulations requiring such takeback

This chapter will include the results to date through a discussion of the Six Sigma study. The results of the study will provide information for recommendations that will be examined in Chapter Five.

European Union requirements – Goal 1(b)

The Six Sigma process is summarized in the acronym *DMAIC* (Define-Measure-Analyze-Implement-Control). The two goals listed in the statement of the thesis problem are the definition for the Define stage of the Six Sigma study. Compliance with the European Union's WEEE directive is necessary because some 40% of XYZ's sales of Product One and Product Two are in Europe. However, it is XYZ managers in Europe are responsible for WEEE directive compliance in the EU.

Good corporate environmental citizen – Goal 1(a)

XYZ has been a leader in the field of product stewardship and environmental responsibility since the mid-1970s. Thus it is important that the hardgoods takeback scheme avoid any association with the types of disposal practices that have created a scandal in Asia. For this reason vendor selection for hardgoods recycling is very important to XYZ. The corporate policy on environmental sustainability is the overriding document guiding the selection process. In practical terms it means that the vendor must be audited and approved by XYZ's recycled goods department.

Vendor selection for recycling is not, however, a major concern for the customers. Surveys show they are very satisfied with XYZ's commitment to environmental stewardship. It is a factor in many purchasing decisions because customers expect that commitment to continue. XYZ is also vitally concerned. XYZ is committed to managing its own waste and not shipping the problem overseas. This is a requirement for vendor selection. The hope at the beginning of the project is that Products One and Two would contain enough recyclable material that a large portion of the cost of the service could be recouped in this way. Evaluation of units by vendors proved this to be untrue.

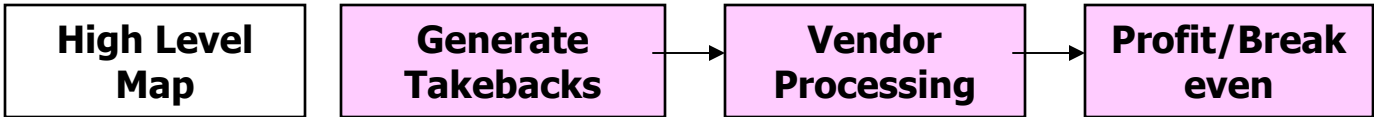
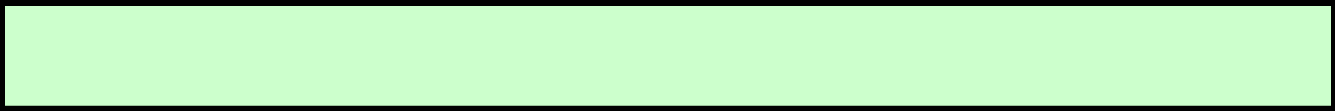
Most of the electronic components are outdated. They cannot be used in new machines. Improved electronics, in fact, is the main reason new models are introduced. Nor has a use for the electronic components been found for other units in Division One or in XYZ as a whole. Vendors say there is no market in other companies for XYZ's intact electronics, either. This means they must be reprocessed to collect the heavy metals in them. XYZ's environmental commitment requires this be done in an environmentally safe fashion, with due consideration for the health of the workers.

Some metals are available for recycling, such as aluminum. It had been hoped that copper coils would be a major source of income for the hardgoods takeback scheme. However, most of the copper contains alloys that improve its performance. That copper can be recycled, but the price paid to XYZ is substantially lower than if the copper were pure. The remainder of the units is mostly plastic, with some wood. The plastic is generally treated with brominated flame-retardants that make recycling difficult, if not impossible. It generally ends up as incinerator fuel.

The monitors on Product One are cathode ray tubes (CRTs) that contain up to eight pounds of lead used as shielding in the glass display screen. It would be environmentally unsound to simply dispose of the CRTs in a landfill. The inevitable breakage could free that lead to disperse into the air or leech into the water. Certification that the selected recycle vendor will reprocess the CRTs to collect the lead is a requirement to gain certification to do business with XYZ.

U.S. takeback – Goal 2

The “process variable map” describes the major activities and tasks that need to occur in order for the hardgoods takeback project to be successful. The Six Sigma Green Belt team drew on an expired, limited program to recycle Product Three and Product Four as a source of experience. These machines were taken in trade for new equipment, shipped to the manufacturing plant, and stripped of certain parts that are no longer made and that will be used as spare parts for existing machines. The process variable map described the major activities that took place in the expired takeback program. These steps served as the model for the projected process variable map for the new takeback program.

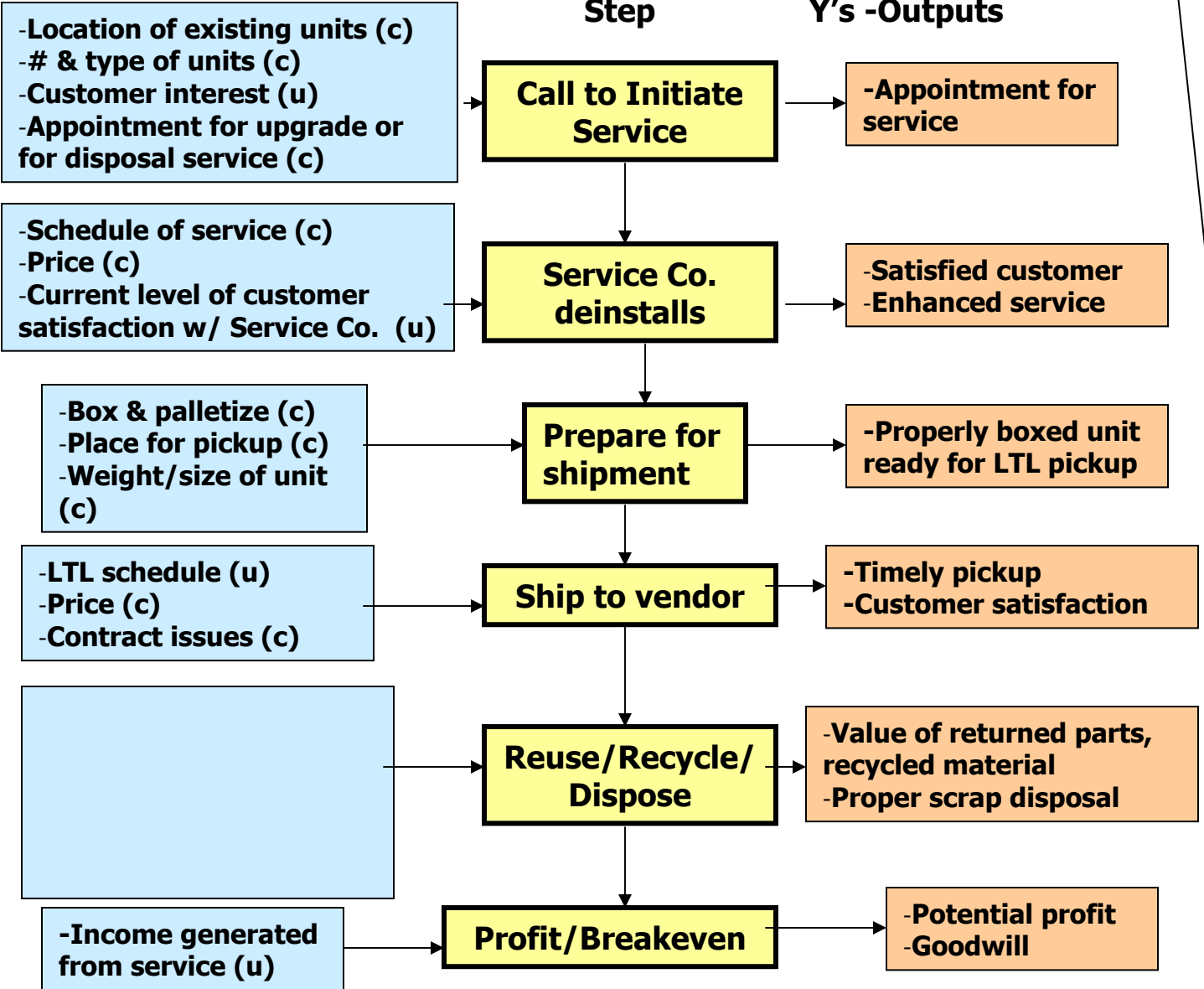


X's - Inputs

PROCESS MAP

Step

Y's -Outputs



Project Y – Improve end-of-life for Division One hardware to include a service to the customer. Increase # of units returned for e-o-l from 0% to 25%

The “High Level Process Map” showed that the first need is to generate customer requests to utilize the takeback service. The next step is to get the unit to the vendor. The final step is to price the service so that Division will either make a dollar profit, or, at the very least, breakeven and use the service to enhance its reputation as a corporate leader in the field of environmental responsibility. This could then be used as a marketing tool to help increase sales on new units.

The detailed process map breaks the process into more discrete steps that associated measurable inputs and outputs. The first X is to determine where existing machines are located. Many of these machines are 25 years old, or older. At the time of the original sale, product takeback was not a concern. Most data is for customers only, who may have one or multiple machines in one or multiple locations. This is unknown. However, it is listed as “c”, a controlled variable, because the information is discrete. Customer interest is, at this time, unknown, so it is “u”, uncontrolled. Sufficient customer interest will initiate a step (in yellow) to make an appointment for deinstallation service (an output, y, in orange).

The next step is for the service company to perform the deinstall. The schedule and the price are controlled, but current customer satisfaction is not. In fact, since XYZ subcontracted this service to an outside vendor, XYZ’s Quality Assurance department has measured a decrease in customer satisfaction with this area of service. Improving and controlling this variable is an important output.

The next step is to prepare the unit for shipment. The unit cannot simply be placed on a pallet and strapped down. LTL haulers (less-than-[full trailer] load) require the unit to be placed in a box on a pallet. This is easily done if a new unit is being installed at the

same time. The old unit can be placed in the new unit's box. Otherwise a padded van, like a home furnishings mover, is required at about three times the LTL's rates.

Obviously, this should be avoided in order to make the project's monetary goal. A method must be devised to supply a proper box if the unit is to be deinstalled without a replacement being installed at the same time. Then the unit must be sent to an XYZ certified recycler, as discussed in the "Good corporate environmental citizen" section.

The final step in the process map is to generate a profit, or break even. There are two sources of income. The first is the value of the recycled units. The second is the fee charged to the customer. XYZ will currently deinstall unit for a customer who is not upgrading to a new unit. Division One's service unit does not like these calls, and has priced the service high in order to discourage orders. However, they do get several dozen calls per month at \$350 per call. The challenge is to combine the fee charged by the deinstallation subcontractor (about \$250 per unit), the cost of shipping, and fee charged by the vendor for service to fit the \$350, plus the small amount from recycled products.

Selection of a certified vendor has a significant impact on transportation costs. Two general possibilities exist. The first is to ship all units to the Chicago area where two XYZ certified vendors are located. The cost to ship a unit to Chicago LTL from either the East or West coast of the United States is about \$125. The shipment cost would not be less than \$100 from any location.

Another alternative would be to bring the units to an XYZ facility located near the customer for shipment to Chicago in an XYZ truck. These trucks generally return empty and would charge a mere nominal rate for the service. The issue would be getting the unit from the customer to the XYZ facility in their area, and then from the XYZ Chicago

facility to the Chicago vendors. The handling charges at both ends might make it just as easy to use an LTL hauler. However, in some cases this could be an economical alternative.

The second possibility is to select a vendor with a national presence in order to reduce shipping costs. The most likely choice is the largest U.S. vendor, Recycle America, an electronics-recycling subsidiary of Waste Management, Inc. (WMI). They are an XYZ certified vendor and a participant in the National Electronic Products Stewardship Initiative (NEPSI). They have reprocessing facilities in Phoenix, AZ; Houston, TX; Minneapolis, MN; and Kernersville, NC, and 160 drop-off locations. Division One is working closely with XYZ's resource recovery unit to make the final vendor selection. Once the vendor is selected, the team can get a quote for the cost they would charge per unit. With deinstallation, shipping, and vendor costs, a price to the customer can be determined. Once this is done the marketing of the service can begin.

The cause-and-effect (C&E) matrix is the tool used to prioritize the process map inputs for action by the Six Sigma team. It helps relate the key X's (customer requirements) to the key Y's (desired outputs) noted in the process map. The outputs (Y's) are identified and assigned an importance factor on a 1-to-10 scale. According to Six Sigma methodology, the ideal number of outputs is between three and seven. The process steps (X's) are listed and correlated to the outputs. Each process step is given an importance rating of 0, 1, 3, or 9. Zero means there is no relationship between the input and the output, and nine means there is a direct and strong impact. These numbers are cross-multiplied to give a total ranking. The higher the number, the more important is the issue. The 0-1-3-9 scale is designed to create a broad spread and avoid closely matched

totals. The final step is to apply team judgments to the totals. That is, do the numbers make sense? The C&E matrix is shown on the next page.

Division One C&E Matrix

Importance	10	10	5	7	5	10	
ISSUE	Create desire for appointment for service	Customer satisfied with deinstallation	Properly boxed unit ready for LTL pickup	Timely pickup, customer satisfaction	Value of recycled parts	Profit, goodwill	Total
Locate existing units, # & type	90	0	0	0	0	30	120
Customer interest	90	0	0	0	0	90	180
Appointment for service	90	30	15	63	0	90	288
Schedule deinstallation service	30	90	15	21	0	30	186
Price of service	90	30	15	21	45	90	291
Customer satisfaction with service co.	30	90	15	63	0	30	228
Box & palletize	10	30	45	63	0	30	178
Place for pickup	30	90	90	21	0	30	261
Weight/size of unit	10	10	30	21	15	90	176
LTL schedule	90	30	30	63	0	90	303
LTL price	10	10	10	7	45	90	172
Contract issues	90	10	0	0	45	0	145
Cost of recycle vendor service	90	0	0	0	45	90	225
Geographic presence	0	0	0	0	15	90	105
Adherence to XYZ Env. policy	30	0	0	0	0	90	120

Income to XYZ from service	90	30	1	21	45		90	277
----------------------------	----	----	---	----	----	--	----	-----

The Six Sigma team decided to focus on the five issues with the highest scores, from 261 and up. “Income to XYZ from service” and “Price of service” were in the top five. This is not surprising given that the project “Project Y” is to increase the number of units returned and to profit or breakeven from the service.

Three of the highest items were “Appointment for service,” “Place for pickup [place the boxed and palletized unit where the LTL hauler can get to it],” and “LTL schedule, which was the highest score and the only one to break 300” This was a bit of a surprise to the team that three of the top five items were related to the work provided by the deinstallation subcontractor. Upon consideration, however, it makes sense. Customers have options in the disposal of their units. If they become frustrated trying to deal with XYZ due to poor service of either the deinstallation or the pick-up of the boxed unit, they could seek alternative disposal methods. The team will be working with the service department of Division One to improve service in this area.

The product takeback team has completed the define and measure portions of the methodology. The next step will be to utilize the Failure Mode and Effects Analysis (FMEA) to identify shortcomings in the recent takeback of Products Three and Four and how those lessons can be applied to a Product One and Two-takeback scheme. The C&E matrix and FMEA results will help prioritize tasks so that those with the most significant impact on the success of the project can be identified. Resolution of these tasks will get proportionately greater resources than lower priority tasks.

The improvement phase will utilize Design of Experiments (DoE). Experiments will be conducted to see how the takeback process can be improved. Experiments are planned to improve the deinstallation service, to try different transportation modes from the customer to the recycling vendor, and to test different recycling vendors,. Each experiment will be done independently so its effect on the outcome of the project can be most clear.

The e-waste project will conclude with a control plan. This plan is intended to institutionalize the results of the project. The control plan requires documented procedures, work instructions, record keeping, and auditing. This means that anyone assigned to this task in the future will have procedures to follow, and will not have to reinvent the wheel. Six Sigma methodology indicates that without a control plan, project gains are often reduced from six sigma to about 1.5 sigma.

Summary

The European Union's WEEE directive brought the issue of waste electrical and electronic equipment to the attention of employees in Division One of the XYZ Corp. Division management made the decision to investigate whether a service business could be created in the United States to takeback Products One and Two. The system has to protect XYZ's reputation in the area of environmental stewardship, and either create a profit or breakeven. A Six Sigma team was formed to use the DMAIC (Define, Measure, Analyze, Improve, Control) process to do the investigation. A process map was created, drawing up an existing, limited takeback service. A cause-and-effect (C&E) matrix was created to prioritize action on issues identified in the process map.

Results of the C&E matrix will be fed into a Failure Mode and Effects Analysis (FMEA) to allocate resources to address the issues. Experiments will be conducted to improve the process. Control procedures will be put into place to institutionalize the gains. Results will be audited to make sure the process is being followed and remains effective.

CHAPTER FIVE – Summary, conclusions, and recommendations

This chapter contains a summary of the study, conclusions based on the preliminary work done thus far in the study, and recommendations for further study.

Summary

Restatement of the problem

The purpose of this study is to:

5. Determine what options are available to XYZ to dispose of its end-of-life electronic hardgoods in a manner that:
 - a. Maintains its industry-leading reputation as a good corporate environmental citizen
 - b. Complies with European Union directives and any other laws and regulations
6. Determine if an electronic hardgoods takeback program for Product One and Product Two can be developed in the United States prior to the enactment of laws and regulations requiring such takeback.

Methods and procedures

The study was conducted using Six Sigma methodology. The methodology used in this study is Six Sigma. Six Sigma is a process management tool designed to reduce variability in output, improve process control, improve quality, and reduce defects. This is the corporate choice of XYZ Corp. Six Sigma follows the DMAIC model – **D**efine, **M**easure, **A**nalyze, **I**mprove, and **C**ontrol.

A “process variable map” was created to highlight the action steps required for a electronic hardgoods takeback program in the United States. The process variable map described the major activities that took place in an expired takeback program used to gather spare parts from Product Three and Four. These steps served as the model for the projected process variable map for the new takeback program. Three major steps were identified: generate takebacks, process at a vendor, and make a profit (or at least break even). These were then divided into six process steps.

A cause-and-effect (c&e) matrix was created to prioritize the process map inputs for action by the Six Sigma team. It helped relate the key X’s (customer requirements) to the key Y’s (desired outputs) noted in the process map. The outputs (Y’s) were identified and assigned an importance factor on a 1-to-10 scale. The process steps (X’s) are listed and correlated to the outputs. Each process step is given an importance rating of 0, 1, 3, or 9. These numbers are cross-multiplied to give a total ranking. The higher the number, the more important is the issue. The final step was to apply team judgments to the totals. That is, did the numbers make sense? Action was to be taken on the five highest ranking items identified in the c&e matrix.

Major findings

The WEEE (Waste Electrical and Electronic Equipment) directive requires a takeback program in European Union member states no later than 2006. Forty percent of Division One’s sales are in Europe and compliance is necessary. The takeback program must also be done in a manner that does not allow hazardous materials in the hardgoods to be released into the environment. This is a requirement of XYZ’s corporate policy on

environmental sustainability. It is also a corporate value to maintain a three-decade old reputation as a world-class, industry leading environmental steward.

Takeback programs are not mandated for hardgoods in the United States. There are limited restrictions on disposing of CRTs in landfills. The current business model places responsibility for disposal of end-of-life goods with the consumer, not with XYZ or any other producer. XYZ wants to create a takeback program to perhaps make a profit, but also to enhance its environmental reputation in a manner that will give it an advantage in the marketplace.

Conclusions

XYZ will comply with the European Union's WEEE directive. Upper-level managers and directors in Europe have created a team to bring the entire corporation, including Division One, into compliance. If this were not to happen, electrical and electronic equipment produced by XYZ could not be sold in Europe. Noncompliance would also result in fines for the failure to process goods already in the marketplace.

Surveys show that customers either like or accept the idea of a takeback program in the United States for Product One and Product Two. They like the idea of partnering with XYZ in a program that has a positive impact on the physical environment. Analysis with the process variable map and the c&e matrix show that satisfactory customer service at the time of deinstallation is a critical variable in a successful program. Current levels of customer satisfaction are too low to sustain a successful takeback program. Service improvements are expected to lead to increased use of a takeback service.

However, a near-term XYZ takeback program in the United States for Product One and Product Two is not certain at this time. The major factor is cost. The current

deinstallation charge, combined with the amount gained from recovered materials, does not seem to be greater than the cost of deinstallation service, transportation, and vendor processing. Lowering the cost of transportation is critical. Experimentation will show if utilization of different, or a variety, of recycle vendors can increase the amount of money from recovered materials, or lower the cost charged for the processing service. For reasons of environmental reputation, export disposal is not an option, despite the cost advantage over proper recycling.

Recommendations

1. The Green Belt team needs to meet with the service manager who will implement the takeback project, managers, and marketing people to establish a price for the service that will at least break even. Establishing a service price that customers will be willing to pay is a requirement of determining whether or not the takeback program will proceed.
2. Once the price has been established, the legal department must draft an initial service plan. The plan must be documented in a form that will allow the CSRs to communicate the details of the plan to potential customers of the takeback service.
3. Data must be collected on the results of the initial plan: how many units come back to XYZ vs. how many are disposed of by customers in a different fashion; why customers do not choose to use XYZ's service; what changes can be implemented within the goal of a breakeven service to increase the number of units coming back to XYZ; how are the vendors performing and can anything be done to decrease the fee charged to XYZ for the service; and how can transportation costs be minimized.

4. Marketing should incorporate the takeback service in literature directed to potential and existing customers, and sales representatives must be taught to include this service as a benefit of selecting an XYZ product vs. a competitor's product. Division One surveys have established that a majority of customers are willing to pay a premium price for a product that will be disposed of properly at end-of-life. This is especially true when there is no established, institutional way for them to dispose of the unit on their own.
5. Division One needs to publicize the takeback effort within XYZ corporation. One Division's efforts and successes are not ordinarily communicated to other Divisions. This deficit hinders the ability of XYZ to leverage its size as a modest producer of a variety of electrical and electronic equipment in the e-waste arena. Corporate-wide adoption of a takeback policy would greatly enhance the marketability of the service of each Division that produces electronic hardgoods.
6. Design for Environment (DfE) should immediately become a requirement for new product development. Division One electronic hardgoods have a usable lifespan of several decades, at a minimum. DfE will help ensure that these products are easier and less costly to dispose of than if DfE were not part of new product development. Requirements of the European Union's Restriction of Hazardous Substances (RoHS) directive means the elimination of lead in solder must become part of DfE.
7. XYZ should affiliate with the National Electronic Product Stewardship Initiative. NEPSI is currently in the best position to influence a national-level approach to end-of-life electronic waste. The European experience of e-waste recycling before the WEEE directive was adopted, and now that it has been adopted, shows that it is vital

to have a common approach to who will pay for the service. Disparate approaches leave producers no incentive to offer a takeback service that might price their product out of the market compared to a product that does not offer such a service, and such a cost. A common approach, even a “front-end” consumer pays approach, would level the playing field and increase the likelihood that a much higher percentage of e-waste will be properly recycled than is the case today.

References

2003 Threshold Limit Values for Chemical Substances and Physical Agents. (2003).

American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

4th annual computer report card. (2003, January 9). *Silicon Valley Toxics Coalition*.

Retrieved April 17, 2003, from <http://www.svtc.org/cleancc/pubs/2002report.htm>

Background facts, electrical and electronic equipment recycling. (2002). Oxford Brookes

University, Oxford, United Kingdom. Retrieved April 17, 2003, from <http://www.brookes.ac.uk/eie/weee.htm>

Bell, Dave. (2002). New bill would establish national computer recycling program.

Retrieved April 19, 2003, from http://www.analogzone.com/col_0724.htm

California Recycles web site home page. (2003, April). Retrieved April 17, 2003, from

<http://www.cawrecycles.org>

Churchman-Davies, Jonathan. (2002, November). Just a WEEE problem....

Environmental Technology, 48 (6), 38-40.

Community strategy for waste management. (1996, July 30). Commission of the

European Communities. Retrieved April 17, 2003, from <http://www.eel.nl/docs/waste.htm>

Computer TakeBack Campaign slams Bush EPA's plan to protect Dell, electronics

manufacturers. (2003, January 11). *Computer TakeBack Campaign*. Retrieved

April 19, 2003, from http://www.grn.org/e-scrap/e-scrap_release_01-11-03.html

Computer take back and recycling: Current initiatives. (n.d.). *As You Sow Foundation*.

Retrieved April 19, 2003, from <http://www.asyousow.org/>

- Dude, why won't they take back my old Dell? (2002, March). *Computer TakeBack Campaign*. Retrieved April 19, 2003, from http://www.grn.org/escrap/Dell_TakeBack_Report.pdf
- Electrical and Electronic Equipment directive. (2001, February) Working paper for a Directive of the European Parliament and of the Council. *Official Journal of the European Union (English)*. Retrieved June 9, 2003, from http://europa.eu.int/comm/enterprise/electr_equipment/eee/workdoc.pdf
- Electronics: Industry initiatives. (2002, December 26). U.S. Environmental Protection Agency. Retrieved April 19, 2003, from <http://epa.gov/epr/products/eindust.html>
- Electronics: International initiatives. (n.d.). U.S. Environmental Protection Agency. Retrieved June 9, 2003, from <http://www.epa.gov/epaoswer/non-hw/reduce/epr/products/eintern.html>
- Environment: A reduction in landfill waste is on the way. (1999, June). *European Union newsletter Vol. 10*. Retrieved April 19, 2003, from <http://jpn.cec.eu.int/english/info-resources/6-6-10-13.htm>
- Eurochambres' joint resolution on the weee directive. (n.d.). Retrieved April 19, 2003, from http://www.eurochambres.be/whatwesay/keypolicies/pdf/environment_WEEE_pp.pdf
- Fridge recycling. (n.d.). *LetsRecycle.com*. Retrieved April 19, 2003, from <http://www.letsrecycle.com/materials/metals/news.jsp?story=1002>
- Garza, Mariel. (2003, February 12). Electronics recycling proposed [Electronic version]. *LA Daily News*. Retrieved April 19, 2003, from <http://www.dailynews.com/Stories/0,1413,200%257E20954%257E1175713,00.html?search=filter>

- Gattuso, Dana Joel. (2002, August 9). Talking E-Trash. Retrieved June 9, 2003, from <http://www.cei.org/gencon/016,03160.cfm>
- Goodman, Peter S. (2003, February 24). China serves as dumping site for computers [Electronic version]. *Washington Post*. Retrieved April 19, 2003, from <http://www.washingtonpost.com/ac2/wp-dyn/A56653-2003Feb24?language=printer>
- Goosey, Martin. (2002, August 31). Conquering refrigerator mountain. *CircuitTree*. Retrieved April 19, 2003, from http://www.circuitree.com/ct/cda/articleinformation/features/bnp__features__item/0,2133,83312,00.html
- Gordon, Jon. (2003, April 10). Dell sets recycling goals [Streaming audio]. *Future Tense*. Retrieved April 19, 2003, from <http://news.mpr.org/programs/futuretense/>
- Haugsten, Camilla. (2002, November 14). Bellona discusses individual producer responsibility in the European Parliament. *The Environmental Foundation Bellona*. Retrieved April 19, 2003, from http://www.bellona.no/en/industry_and_wastes/wastes/27236.html
- Hertsgaard, Mark. (2003, January 16). Trashing the Environment. *The Nation*. Retrieved April 19, 2003, from <http://www.thenation.com/doc.mhtml?i=20030203&s=hertsgaard>
- Industry market profile: computer monitors, volume and technology trends. (n.d.). U.S. Environmental Protection Agency. Retrieved April 17, 2003, from http://www.epa.gov/opptintr/dfe/pubs/comp-dic/tech_reports/SEC2-0.pdf
- Intel: Lead-free solutions. (n.d.). Retrieved April 29, 2003, from <http://developer.intel.com/research/silicon/leadfree.htm>

Joint press statement of industry, consumer and environmental organisations on producer responsibility in the waste electrical and electronic equipment (WEEE) directive.

(n.d.). Retrieved April 19, 2003, from <http://www.eeb.org/activities/waste/joint%20statement%20on%20producer%20responsibility.pdf>

Lamvik, T., Myklebust, O., & Miljeteig, G. (2002, May). The AEOLOS methodology.

2002 IEEE international symposium on electronics and the environment.

Retrieved April 19, 2003, from [http://search.ieeexplore.ieee.org/search97/s97is.vts?Action=Search&queryText=%28Lamvik%20T.<IN>au%20\)&](http://search.ieeexplore.ieee.org/search97/s97is.vts?Action=Search&queryText=%28Lamvik%20T.<IN>au%20)&SearchPage=authors.jsp&ResultTemplate=lpadv_crst.hts&Filter=fld_sch.hts)

[SearchPage=authors.jsp&ResultTemplate=lpadv_crst.hts&Filter=fld_sch.hts](http://search.ieeexplore.ieee.org/search97/s97is.vts?Action=Search&queryText=%28Lamvik%20T.<IN>au%20)&SearchPage=authors.jsp&ResultTemplate=lpadv_crst.hts&Filter=fld_sch.hts)

[&ViewTemplate=lpdocview.hts&SortField=pyr&SortOrder=desc&ResultCount=](http://search.ieeexplore.ieee.org/search97/s97is.vts?Action=Search&queryText=%28Lamvik%20T.<IN>au%20)&SearchPage=authors.jsp&ResultTemplate=lpadv_crst.hts&Filter=fld_sch.hts)

15

Lee, Sherry. (2002, May 12). *Ghosts in the Machines*. South China Morning News

Magazine. Retrieved June 8, 2003 from [http://www.ban.org/Library/](http://www.ban.org/Library/ghosts_in.html)

[ghosts_in.html](http://www.ban.org/Library/ghosts_in.html)

Moore's Law. (n.d.). Intel Research. Retrieved June 9, 2003, from [http://www.intel.com/](http://www.intel.com/research/silicon/mooreslaw.htm)

[research/silicon/mooreslaw.htm](http://www.intel.com/research/silicon/mooreslaw.htm)

Municipal solid waste management: Landfills. (2000) United Nations Environment

Programme, International Environmental Technology Centre, Newsletter and

Technical Publications. Retrieved April 17, 2003, from [http://www.unep.or.jp/](http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/RO/Europe/Topic_e.asp)

[ietc/ESTdir/Pub/MSW/RO/Europe/Topic_e.asp](http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/RO/Europe/Topic_e.asp)

National electronics product stewardship dialogue achieves milestone: Stakeholders agree

on financing approach for management of used electronics. (2003, March 19).

Retrieved April 19, 2003, from <http://eerc.ra.utk.edu/clean/nepsi/pdfs/nepsipress3>

-19.pdf

National Electronics Product Stewardship Initiative (NEPSI) home page. (n.d.).

Retrieved April 19, 2003, from <http://eerc.ra.utk.edu/clean/nepsi/>

National Electronics Product Stewardship Initiative (NEPSI). (n.d.). Retrieved April 19,

2003, from <http://www.epa.gov/epr/products/nepsi.html>

A “new” approach to the environment. (2002, January). *European Commission*.

Retrieved April 17, 2003, from http://europa.eu.int/comm/enterprise/electr_equipement/eee/background.htm

Nxtcycle expands its e-waste recycling program in California. (2003, February 21).

Retrieved April 19, 2003, from <http://www.nxtcycle.com/newsletters/News%203-21-03.pdf>

Position Paper on the European Union Directive on Waste Electrical and Electronic

Equipment. (n.n.). Computer Professionals for Social Responsibility. Retrieved June 9, 2003, from <http://www.cpsr.org/program/environment/WEEEPaper.html>

Raymond, Michele. (2002, March). *2002 IEEE international symposium on electronics*

and the environment. Retrieved April 19, 2003, from <http://ieeexplore.ieee.org/Xplore/Deny.jsp?url=/iel5/7861/21650/01003245.pdf?isNumber=21650&prod=IEEE+CNF&arnumber=1003245&arSt=89&ared=92&arAuthor=Raymond%2C+M.%3B&code=2>

Recupel? (2003, April). Retrieved April 18, 2003, from [http://www.backoffice.be/shop/](http://www.backoffice.be/shop/recupel.html.asp)

[recupel.html.asp](http://www.backoffice.be/shop/recupel.html.asp)

- Restriction of hazardous substances directive. (2003, February 13). *Official Journal of the European Union (English)*. Retrieved April 17, 2003, from <http://164.36.253.20/sustainability/pdfs/finalrohs.pdf>
- Schoenberger, Karl. (2002, November 23, 24, 25). *Where Computers Go to Die*. San Jose Mercury-News. Retrieved June 9, 2003 from <http://cawrecycles.org/> (E-Waste/Where Computers Go to Die)
- Shabi, Rachel. (2002, November 30). The E-Waste Land. Retrieved June 9, 2003, from http://www.ban.org/ban_news/the_e.html
- Six Sigma DMAIC Methodology for Green Belts. (2002, April 3). Sigma Breakthrough Technologies, Inc., San Marcos, TX
- SOLDERTEC home page. (n.d.). Retrieved April 29, 2003, from <http://lead-free.org/soldertec/index.html>
- Thorpe, Beverley. (1999, May 16). Background document on hazards and waste from computers. *Trans-Atlantic Network for Clean Production*. Retrieved April 17, 2003, from <http://www.cpa.most.org.pl/computer.html>
- UK fridge fiasco to be probed as new equipment trials begin. (2002, January 25). *edie online*. Retrieved April 19, 2003, from <http://www.edie.net/news/Archive/5097.cfm>
- Waste. (2003, April 8). *European Commission Environment Policies*. Retrieved April 17, 2003, from <http://europe.eu.int/comm/environment/waste/index.htm>
- Waste electrical and electronic equipment directive. (2003, February 13). *Official Journal of the European Union (English)*. Retrieved April 17, 2003, from <http://164.36.253.20/sustainability/pdfs/finalweee.pdf>

Waste generation and management. (n.d.). European Environment Agency. Retrieved April 17, 2003, from <http://reports.eea.eu.int/92-9157-202-0/en/3.7.pdf>

WEEE targets. (n.d.). *LetsRecycle.com*. Retrieved April 19, 2003, from <http://www.letsrecycle.com/legislation/weee200105b>

Wood, Lindsay. (2001). Old pc's toxic in landfill sites. *Galt Global Review*. Retrieved April 17, 2003, from http://www.galtglobalreview.com/business/toxic_pcs.html

APPENDIX A**DIRECTIVE 2002/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on waste electrical and electronic equipment (WEEE)**

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

Having regard to the proposal from the Commission,

Having regard to the Opinion of the Economic and Social Committee,

Having regard to the Opinion of the Committee of Regions,

Acting in accordance with the procedure laid down in Article 251 of the Treaty in the light of the joint text approved by the Conciliation Committee on 8 November 2002,

Whereas:

(1) The objectives of the Community's environment policy are, in particular, to preserve, protect and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally. That policy is based on the precautionary principle and principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.

(2) The Community programme of policy and action in relation to the environment and sustainable development (Fifth Environmental Action Programme) (5) states that the achievement of sustainable development calls for significant changes in current patterns of development, production, consumption and behaviour and advocates, *inter alia*, the reduction of wasteful consumption of natural resources and the prevention of pollution. It mentions waste electrical and electronic equipment (WEEE) as one of the target areas to be regulated, in view of the application of the principles of prevention, recovery and safe disposal of waste.

(3) The Commission Communication of 30 July 1996 on review of the Community strategy for waste management states that, where the generation of waste cannot be avoided, it should be reused or recovered for its material or energy.

(4) The Council in its Resolution of 24 February 1997 on a Community strategy for waste management insisted on the need for promoting waste recovery with a view to reducing the quantity of waste for disposal and saving natural resources, in particular by reuse, recycling, composting and recovering energy from waste and recognised that the choice of options in any particular case must have regard to environmental and economic effects

but that until scientific and technological progress is made and life-cycle analyses are further developed, reuse and material recovery should be considered preferable where and in so far as they are the best environmental options. The Council also invited the Commission to develop, as soon as possible, an appropriate follow-up to the projects of the priority waste streams programme, including WEEE.

(5) The European Parliament, in its Resolution of 14 November 1996, asked the Commission to present proposals for Directives on a number of priority waste streams, including electrical and electronic waste, and to base such proposals on the principle of producer responsibility. The European Parliament, in the same Resolution, requests the Council and the Commission to put forward proposals for cutting the volume of waste.

(6) Council Directive 75/442/EEC of 15 July 1975 on waste provides that specific rules for particular instances or supplementing those of Directive 75/442/EEC on the management of particular categories of waste may be laid down by means of individual Directives.

(7) The amount of WEEE generated in the Community is growing rapidly. The content of hazardous components in electrical and electronic equipment (EEE) is a major concern during the waste management phase and recycling of WEEE is not undertaken to a sufficient extent.

(8) The objective of improving the management of WEEE cannot be achieved effectively by Member States acting individually. In particular, different national applications of the producer responsibility principle may lead to substantial disparities in the financial burden on economic operators. Having different national policies on the management of WEEE hampers the effectiveness of recycling policies. For that reason the essential criteria should be laid down at Community level.

(9) The provisions of this Directive should apply to products and producers irrespective of the selling technique, including distance and electronic selling. In this connection the obligations of producers and distributors using distance and electronic selling channels should, as far as is practicable, take the same form and should be enforced in the same way in order to avoid other distribution channels having to bear the costs of the provisions of this Directive concerning WEEE for which the equipment was sold by distant or electronic selling.

(10) This Directive should cover all electrical and electronic equipment used by consumers and electrical and electronic equipment intended for professional use. This Directive should apply without prejudice to Community legislation on safety and health requirements protecting all actors in contact with WEEE as well as specific Community waste management legislation, in particular Council Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances.

(11) Directive 91/157/EEC needs to be revised as soon as possible, particularly in the light of this Directive.

(12) The establishment, by this Directive, of producer responsibility is one of the means of encouraging the design and production of electrical and electronic equipment which take into full account and facilitate their repair, possible upgrading, reuse, disassembly and recycling.

(13) In order to guarantee the safety and health of distributors' personnel involved in the take-back and handling of WEEE, Member States should, in accordance with national and Community legislation on safety and health requirements, determine the conditions under which take-back may be refused by distributors.

(14) Member States should encourage the design and production of electrical and electronic equipment which take into account and facilitate dismantling and recovery, in particular the re-use and recycling of WEEE, their components and materials. Producers should not prevent, through specific design features or manufacturing processes, WEEE from being reused, unless such specific design features or manufacturing processes present overriding advantages, for example with regard to the protection of the environment and/or safety requirements.

(15) Separate collection is the precondition to ensure specific treatment and recycling of WEEE and is necessary to achieve the chosen level of protection of human health and the environment in the Community. Consumers have to actively contribute to the success of such collection and should be encouraged to return WEEE. For this purpose, convenient facilities should be set up for the return of WEEE, including public collection points, where private households should be able to return their waste at least free of charge.

(16) In order to attain the chosen level of protection and harmonised environmental objectives of the Community, Member States should adopt appropriate measures to minimise the disposal of WEEE as unsorted municipal waste and to achieve a high level of separate collection of WEEE. In order to ensure that Member States strive to set up efficient collection schemes, they should be required to achieve a high level of collection of WEEE from private households.

(17) Specific treatment for WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or the waste stream. Such treatment is the most effective means of ensuring compliance with the chosen level of protection of the environment of the Community. Any establishment or undertakings carrying out recycling and treatment operations should comply with minimum standards to prevent negative environmental impacts associated with the treatment of WEEE. Best available treatment, recovery and recycling techniques should be used provided that they ensure human health and high environmental protection. Best available treatment, recovery and recycling techniques may be further defined in accordance with the procedures of Directive 96/61/EC.

(18) Where appropriate, priority should be given to the reuse of WEEE and its components, subassemblies and consumables. Where reuse is not preferable, all WEEE

collected separately should be sent for recovery, in the course of which a high level of recycling and recovery should be achieved. In addition, producers should be encouraged to integrate recycled material in new equipment.

(19) Basic principles with regard to the financing of WEEE management have to be set at Community level and financing schemes have to contribute to high collection rates as well as to the implementation of the principle of producer responsibility.

(20) Users of electrical and electronic equipment from private households should have the possibility of returning WEEE at least free of charge. Producers should therefore finance collection from collection facilities, and the treatment, recovery and disposal of WEEE. In order to give maximum effect to the concept of producer responsibility, each producer should be responsible for financing the management of the waste from his own products. The producer should be able to choose to fulfill this obligation either individually or by joining a collective scheme. Each producer should, when placing a product on the market, provide a financial guarantee to prevent costs for the management of WEEE from orphan products from falling on society or the remaining producers. The responsibility for the financing of the management of historical waste should be shared by all existing producers in collective financing schemes to which all producers, existing on the market when the costs occur, contribute proportionately. Collective financing schemes should not have the effect of excluding niche and low-volume producers, importers and new entrants. For a transitional period, producers should be allowed to show purchasers, on a voluntary basis at the time of sale of new products, the costs of collecting, treating and disposing in an environmentally sound way of historical waste. Producers making use of this provision should ensure that the costs mentioned do not exceed the actual costs incurred.

(21) Information to users about the requirement not to dispose of WEEE as unsorted municipal waste and to collect WEEE separately, and about the collection systems and their role in the management of WEEE, is indispensable for the success of WEEE collection. Such information implies the proper marking of electrical and electronic equipment which could end up in rubbish bins or similar means of municipal waste collection.

(22) Information on component and material identification to be provided by producers is important to facilitate the management, and in particular the treatment and recovery/recycling, of WEEE.

(23) Member States should ensure that inspection and monitoring infrastructure enable the proper implementation of this Directive to be verified, having regard, *inter alia*, to Recommendation 2001/331/EC of the European Parliament and the Council of 4 April 2001 providing for minimum criteria for environmental inspections in the Member States.

(24) Information about the weight or, if this is not possible, the numbers of items of electrical and electronic equipment put on the market in the Community and the rates of collection, reuse (including as far as possible reuse of whole appliances), recovery/

recycling and export of WEEE collected in accordance with this Directive is necessary to monitor the achievement of the objectives of this Directive.

(25) Member States may choose to implement certain provisions of this Directive by means of agreements between the competent authorities and the economic sectors concerned provided that particular requirements are met.

(26) The adaptation to scientific and technical progress of certain provisions of the Directive, the list of products falling under the categories set out in Annex IA, the selective treatment for materials and components of WEEE, the technical requirements for storage and treatment of WEEE and the symbol for the marking of EEE should be effected by the Commission under a committee procedure.

(27) The measures necessary for the implementation of this Directive should be adopted in accordance with Council Decision 1999/468/EC of 28 June 1999 laying down the procedures for the exercise of implementing powers conferred on the Commission,

HAVE ADOPTED THIS DIRECTIVE:

Article 1

Objectives

The purpose of this Directive is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.

Article 2

Scope

1. This Directive shall apply to electrical and electronic equipment falling under the categories set out in Annex IA provided that the equipment concerned is not part of another type of equipment that does not fall within the scope of this Directive. Annex IB contains a list of products which fall under the categories set out in Annex IA.

2. This Directive shall apply without prejudice to Community legislation on safety and health requirements and specific Community waste management legislation.

3. Equipment which is connected with the protection of the essential interests of the security of Member States, arms, munitions and war material shall be excluded from this Directive. This does not, however, apply to products which are not intended for specifically military purposes.

Article 3

Definitions

For the purposes of this Directive, the following definitions shall apply:

- (a) 'electrical and electronic equipment' or 'EEE' means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1 000 Volt for alternating current and 1 500 Volt for direct current;
- (b) 'waste electrical and electronic equipment' or 'WEEE' means electrical or electronic equipment which is waste within the meaning of Article 1(a) of Directive 75/442/EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding;
- (c) 'prevention' means measures aimed at reducing the quantity and the harmfulness to the environment of WEEE and materials and substances contained therein;
- (d) 'reuse' means any operation by which WEEE or components thereof are used for the same purpose for which they were conceived, including the continued use of the equipment or components thereof which are returned to collection points, distributors, recyclers or manufacturers;
- (e) 'recycling' means the reprocessing in a production process of the waste materials for the original purpose or for other purposes, but excluding energy recovery which means the use of combustible waste as a means of generating energy through direct incineration with or without other waste but with recovery of the heat;
- (f) 'recovery' means any of the applicable operations provided for in Annex IIB to Directive 75/442/EEC;
- (g) 'disposal' means any of the applicable operations provided for in Annex IIA to Directive 75/442/EEC;
- (h) 'treatment' means any activity after the WEEE has been handed over to a facility for depollution, disassembly, shredding, recovery or preparation for disposal and any other operation carried out for the recovery and/or the disposal of the WEEE;
- (i) 'producer' means any person who, irrespective of the selling technique used, including by means of distance communication in accordance with Directive 97/7/EC of the European Parliament and of the Council of 20 May 1997 on the protection of consumers in respect of distance contracts:
- (i) manufactures and sells electrical and electronic equipment under his own brand,
 - (ii) resells under his own brand equipment produced by other suppliers, a reseller not being regarded as the 'producer' if the brand of the producer appears on the equipment, as provided for in subpoint (i), or
 - (iii) imports or exports electrical and electronic equipment on a professional basis into a Member State. Whoever exclusively provides financing under or pursuant to any finance agreement shall not be deemed a 'producer' unless he also acts as a producer within the meaning of subpoints (i) to (iii);

(j) ‘distributor’ means any person who provides electrical or electronic equipment on a commercial basis to the party who is going to use it;

(k) ‘WEEE from private households’ means WEEE which comes from private households and from commercial, industrial, institutional and other sources which, because of its nature and quantity, is similar to that from private households;

(l) ‘dangerous substance or preparation’ means any substance or preparation which has to be considered dangerous under Council Directive 67/548/EEC (2) or Directive 1999/45/EC of the European Parliament and of the Council (3).

(m) ‘finance agreement’ means any loan, lease, hiring or deferred sale agreement or arrangement relating to any equipment whether or not the terms of that agreement or arrangement or any collateral agreement or arrangement provide that a transfer of ownership of that equipment will or may take place.

Article 4

Product design

Member States shall encourage the design and production of electrical and electronic equipment which take into account and facilitate dismantling and recovery, in particular the reuse and recycling of WEEE, their components and materials. In this context, Member States shall take appropriate measures so that producers do not prevent, through specific design features or manufacturing processes, WEEE from being reused, unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements.

Article 5

Separate collection

1. Member States shall adopt appropriate measures in order to minimise the disposal of WEEE as unsorted municipal waste and to achieve a high level of separate collection of WEEE.

2. For WEEE from private households, Member States shall ensure that by the 13 August 2005:

(a) systems are set up allowing final holders and distributors to return such waste at least free of charge. Member States shall ensure the availability and accessibility of the necessary collection facilities, taking into account in particular the population density;

(b) when supplying a new product, distributors shall be responsible for ensuring that such waste can be returned to the distributor at least free of charge on a one-to-one basis as long as the equipment is of equivalent type and has fulfilled the same functions as the supplied equipment. Member States may depart from this provision provided they ensure that returning the WEEE is not thereby made more difficult for the final holder and

provided that these systems remain free of charge for the final holder. Member States making use of this provision shall inform the Commission thereof;

(c) without prejudice to the provisions of (a) and (b), producers are allowed to set up and operate individual and/or collective take-back systems for WEEE from private households provided that these are in line with the objectives of this Directive;

(d) having regard to national and Community health and safety standards, WEEE that presents a health and safety risk to personnel because of contamination may be refused for return under (a) and (b). Member States shall make specific arrangements for such WEEE. Member States may provide for specific arrangements for the return of WEEE as under (a) and (b) if the equipment does not contain the essential components or if the equipment contains waste other than WEEE.

3. In the case of WEEE other than WEEE from private households, and without prejudice to Article 9, Member States shall ensure that producers or third parties acting on their behalf provide for the collection of such waste.

4. Member States shall ensure that all WEEE collected under paragraphs 1, 2 and 3 above is transported to treatment facilities authorised under Article 6 unless the appliances are reused as a whole. Member States shall ensure that the envisaged reuse does not lead to a circumvention of this Directive, in particular as regards Articles 6 and 7. The collection and transport of separately collected WEEE shall be carried out in a way which optimises reuse and recycling of those components or whole appliances capable of being reused or recycled.

5. Without prejudice to paragraph 1, Member States shall ensure that by 31 December 2006 at the latest a rate of separate collection of at least four kilograms on average per inhabitant per year of WEEE from private households is achieved. The European Parliament and the Council, acting on a proposal from the Commission and taking account of technical and economic experience in the Member States, shall establish a new mandatory target by 31 December 2008. This may take the form of a percentage of the quantities of electrical and electronic equipment sold to private households in the preceding years.

Article 6

Treatment

1. Member States shall ensure that producers or third parties acting on their behalf, in accordance with Community legislation, set up systems to provide for the treatment of WEEE using best available treatment, recovery and recycling techniques. The systems may be set up by producers individually and/or collectively. To ensure compliance with Article 4 of Directive 75/442/EEC, the treatment shall, as a minimum, include the removal of all fluids and a selective treatment in accordance with Annex II to this Directive.

2. Member States shall ensure that any establishment or undertaking carrying out treatment operations obtains a permit from the competent authorities, in compliance with Articles 9 and 10 of Directive 75/442/EEC. The derogation from the permit requirement

referred to in Article 11(1)(b) of Directive 75/442/EEC may apply to recovery operations concerning WEEE if an inspection is carried out by the competent authorities before the registration in order to ensure compliance with Article 4 of Directive 75/442/EEC. The inspection shall verify:

- (a) the type and quantities of waste to be treated;
- (b) the general technical requirements to be complied with;
- (c) the safety precautions to be taken.

The inspection shall be carried out at least once a year and the results shall be communicated by the Member States to the Commission.

3. Member States shall ensure that any establishment or undertaking carrying out treatment operations stores and treats WEEE in compliance with the technical requirements set out in Annex III.

4. Member States shall ensure that the permit or the registration referred to in paragraph 2 includes all conditions necessary for compliance with the requirements of paragraphs 1 and 3 and for the achievement of the recovery targets set out in Article 7.

5. The treatment operation may also be undertaken outside the respective Member State or the Community provided that the shipment of WEEE is in compliance with Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the European Community. WEEE exported out of the Community in line with Council Regulation (EEC) No 259/93, Council Regulation (EC) No 1420/1999 of 29 April 1999 establishing common rules and procedures to apply to shipments to certain non-OECD countries of certain types of waste and Commission Regulation (EC) No 1547/1999 of 12 July 1999 determining the control procedures under Council Regulation (EEC) No 259/93 to apply to shipments of certain types of waste to certain countries to which OECD Decision C(92)39 final does not apply, shall only count for the fulfilment of obligations and targets of Article 7(1) and (2) of this Directive if the exporter can prove that the recovery, reuse and/or recycling operation took place under conditions that are equivalent to the requirements of this Directive.

6. Member States shall encourage establishments or undertakings which carry out treatment operations to introduce certified environmental management systems in accordance with Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS).

Article 7

Recovery

1. Member States shall ensure that producers or third parties acting on their behalf set up systems either on an individual or on a collective basis, in accordance with Community legislation, to provide for the recovery of WEEE collected separately in accordance with Article 5. Member States shall give priority to the reuse of whole appliances. Until the date referred to in paragraph 4, such appliances shall not be taken into account for the calculation of the targets set out in paragraph 2.

2. Regarding WEEE sent for treatment in accordance with Article 6, Member States shall ensure that, by 31 December 2006, producers meet the following targets:

(a) for WEEE falling under categories 1 and 10 of Annex IA, — the rate of recovery shall be increased to a minimum of 80 % by an average weight per appliance, and — component, material and substance reuse and recycling shall be increased to a minimum of 75 % by an average weight per appliance;

(b) for WEEE falling under categories 3 and 4 of Annex IA, — the rate of recovery shall be increased to a minimum of 75 % by an average weight per appliance, and — component, material and substance reuse and recycling shall be increased to a minimum of 65 % by an average weight per appliance;

(c) for WEEE falling under categories 2, 5, 6, 7 and 9 of Annex IA, — the rate of recovery shall be increased to a minimum of 70 % by an average weight per appliance, and — component, material and substance reuse and recycling shall be increased to a minimum of 50 % by an average weight per appliance;

(d) for gas discharge lamps, the rate of component, material and substance reuse and recycling shall reach a minimum of 80 % by weight of the lamps.

3. Member States shall ensure that, for the purpose of calculating these targets, producers or third parties acting on their behalf keep records on the mass of WEEE, their components, materials or substances when entering (input) and leaving (output) the treatment facility and/or when entering (input) the recovery or recycling facility. The Commission shall, in accordance with the procedure laid down in Article 14(2), establish the detailed rules for monitoring compliance, including specifications for materials, of Member States with the targets set out in paragraph 2. The Commission shall submit this measure by 13 August 2004.

4. The European Parliament and the Council, acting on a proposal from the Commission, shall establish new targets for recovery and reuse/recycling, including for the reuse of whole appliances as appropriate, and for the products falling under category 8 of Annex IA, by 31 December 2008. This shall be done with account being taken of the environmental benefits of electrical and electronic equipment in use, such as improved resource efficiency resulting from developments in the areas of materials and technology. Technical progress in reuse, recovery and recycling, products and materials, and the experience gained by the Member States and the industry, shall also be taken into account.

5. Member States shall encourage the development of new recovery, recycling and treatment technologies.

*Article 8***Financing in respect of WEEE from private households**

1. Member States shall ensure that, by 13 August 2005, producers provide at least for the financing of the collection, treatment, recovery and environmentally sound disposal of WEEE from private households deposited at collection facilities, set up under Article 5(2).

2. For products put on the market later than 13 August 2005, each producer shall be responsible for financing the operations referred to in paragraph 1 relating to the waste from his own products. The producer can choose to fulfil this obligation either individually or by joining a collective scheme. Member States shall ensure that each producer provides a guarantee when placing a product on the market showing that the management of all WEEE will be financed and that producers clearly mark their products in accordance with Article 11(2). This guarantee shall ensure that the operations referred to in paragraph 1 relating to this product will be financed. The guarantee may take the form of participation by the producer in appropriate schemes for the financing of the management of WEEE, a recycling insurance or a blocked bank account. The costs of collection, treatment and environmentally sound disposal shall not be shown separately to purchasers at the time of sale of new products.

3. The responsibility for the financing of the costs of the management of WEEE from products put on the market before the date referred to in paragraph 1 (historical waste) shall be provided by one or more systems to which all producers, existing on the market when the respective costs occur, contribute proportionately, e.g. in proportion to their respective share of the market by type of equipment. Member States shall ensure that for a transitional period of eight years (10 years for category 1 of Annex IA) after entry into force of this Directive, producers are allowed to show purchasers, at the time of sale of new products, the costs of collection, treatment and disposal in an environmentally sound way. The costs mentioned shall not exceed the actual costs incurred.

4. Member States shall ensure that producers supplying electrical or electronic equipment by means of distance communication also comply with the requirements set out in this Article for the equipment supplied in the Member State where the purchaser of that equipment resides.

*Article 9***Financing in respect of WEEE from users other than private households**

Member States shall ensure that, by 13 August 2005, the financing of the costs for the collection, treatment, recovery and environmentally sound disposal of WEEE from users other than private households from products put on the market after 13 August 2005 is to be provided for by producers. For WEEE from products put on the market before 13 August 2005 (historical waste), the financing of the costs of management shall be provided for by producers. Member States may, as an alternative, provide that users other than private households also be made, partly or totally, responsible for this financing.

Producers and users other than private households may, without prejudice to this Directive, conclude agreements stipulating other financing methods.

Article 10

Information for users

1. Member States shall ensure that users of electrical and electronic equipment in private households are given the necessary information about:

- (a) the requirement not to dispose of WEEE as unsorted municipal waste and to collect such WEEE separately;
- (b) the return and collection systems available to them;
- (c) their role in contributing to reuse, recycling and other forms of recovery of WEEE;
- (d) the potential effects on the environment and human health as a result of the presence of hazardous substances in electrical and electronic equipment;
- (e) the meaning of the symbol shown in Annex IV.

2. Member States shall adopt appropriate measures so that consumers participate in the collection of WEEE and to encourage them to facilitate the process of reuse, treatment and recovery.

3. With a view to minimising the disposal of WEEE as unsorted municipal waste and to facilitating its separate collection, Member States shall ensure that producers appropriately mark electrical and electronic equipment put on the market after 13 August 2005 with the symbol shown in Annex IV. In exceptional cases, where this is necessary because of the size or the function of the product, the symbol shall be printed on the packaging, on the instructions for use and on the warranty of the electrical and electronic equipment.

4. Member States may require that some or all of the information referred to in paragraphs 1 to 3 shall be provided by producers and/or distributors, e.g. in the instructions for use or at the point of sale.

Article 11

Information for treatment facilities

1. In order to facilitate the reuse and the correct and environmentally sound treatment of WEEE, including maintenance, upgrade, refurbishment and recycling, Member States shall take the necessary measures to ensure that producers provide reuse and treatment information for each type of new EEE put on the market within one year after the equipment is put on the market. This information shall identify, as far as it is needed by reuse centres, treatment and recycling facilities in order to comply with the provisions of this Directive, the different EEE components and materials, as well as the location of dangerous substances and preparations in EEE. It shall be made available to reuse centres, treatment and recycling facilities by producers of EEE in the form of manuals or by means of electronic media (e.g. CD-ROM, online services).

2. Member States shall ensure that any producer of an electrical or electronic appliance put on the market after 13 August 2005 is clearly identifiable by a mark on the appliance.

Furthermore, in order to enable the date upon which the appliance was put on the market to be determined unequivocally, a mark on the appliance shall specify that the latter was put on the market after 13 August 2005. The Commission shall promote the preparation of European standards for this purpose.

Article 12

Information and reporting

1. Member States shall draw up a register of producers and collect information, including substantiated estimates, on an annual basis on the quantities and categories of electrical and electronic equipment put on their market, collected through all routes, reused, recycled and recovered within the Member States, and on collected waste exported, by weight or, if this is not possible, by numbers. Member States shall ensure that producers supplying electrical and electronic equipment by means of distance communication provide information on the compliance with the requirements of Article 8(4) and on the quantities and categories of electrical and electronic equipment put on the market of the Member State where the purchaser of that equipment resides. Member States shall ensure that the information required is transmitted to the Commission on a two-yearly basis within 18 months after the end of the period covered. The first set of information shall cover the years 2005 and 2006. The information shall be provided in a format which shall be established within one year after the entry into force of this Directive in accordance with the procedure referred to in Article 14(2) with a view to establishing databases on WEEE and its treatment. Member States shall provide for adequate information exchange in order to comply with this paragraph, in particular for treatment operations as referred to in Article 6(5).

2. Without prejudice to the requirements of paragraph 1, Member States shall send a report to the Commission on the implementation of this Directive at three-year intervals. The report shall be drawn up on the basis of a questionnaire or outline drafted by the Commission in accordance with the procedure laid down in Article 6 of Council Directive 91/692/EEC of 23 December 1991 standardising and rationalising reports on the implementation of certain Directives relating to the environment (1). The questionnaire or outline shall be sent to the Member States six months before the start of the period covered by the report. The report shall be made available to the Commission within nine months of the end of the three year period covered by it. The first three-year report shall cover the period from 2004 to 2006. The Commission shall publish a report on the implementation of this Directive within nine months after receiving the reports from the Member States.

Article 13

Adaptation to scientific and technical progress

Any amendments which are necessary in order to adapt Article 7(3), Annex IB, (in particular with a view to possibly adding luminaires in households, filament bulbs and photovoltaic products, i.e. solar panels), Annex II (in particular taking into account new technical developments for the treatment of WEEE), and Annexes III and IV to scientific and technical progress shall be adopted in accordance with the procedure referred to in Article 14(2). Before the Annexes are amended the Commission shall *inter alia* consult

producers of electrical and electronic equipment, recyclers, treatment operators and environmental organisations and employees' and consumer associations.

Article 14

Committee

1. The Commission shall be assisted by the Committee set up by Article 18 of Directive 75/442/EEC.

2. Where reference is made to this paragraph, Articles 5 and 7 of Decision 1999/468/EC shall apply, having regard to Article 8 thereof. The period laid down in Article 5(6) of Decision 1999/468/EC shall be set at three months.

3. The Committee shall adopt its rules of procedure.

Article 15

Penalties

Member States shall determine penalties applicable to breaches of the national provisions adopted pursuant to this Directive. The penalties thus provided for shall be effective, proportionate and dissuasive.

Article 16

Inspection and monitoring

Member States shall ensure that inspection and monitoring enable the proper implementation of this Directive to be verified.

Article 17

Transposition

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 13 August 2004. They shall immediately inform the Commission thereof. When Member States adopt these measures, they shall contain a reference to this Directive or be accompanied by such reference on the occasion of their official publication. The methods of making such a reference shall be laid down by the Member States.

2. Member States shall communicate to the Commission the text of all laws, regulations and administrative provisions adopted in the field covered by this Directive.

3. Provided that the objectives set out in this Directive are achieved, Member States may transpose the provisions set out in Articles 6(6), 10(1) and 11 by means of agreements between the competent authorities and the economic sectors concerned. Such agreements shall meet the following requirements:

(a) agreements shall be enforceable;

(b) agreements shall specify objectives with the corresponding deadlines;

(c) agreements shall be published in the national official journal or an official document equally accessible to the public and transmitted to the Commission;

(d) the results achieved shall be monitored regularly, reported to the competent authorities and the Commission and made available to the public under the conditions set out in the agreement;

(e) the competent authorities shall ensure that the progress reached under the agreement is examined;

(f) in case of non-compliance with the agreement Member States must implement the relevant provisions of this Directive by legislative, regulatory or administrative measures.

4. (a) Greece and Ireland which, because of their overall:

- recycling infrastructure deficit,
- geographical circumstances such as the large number of small islands and the presence of rural and mountain areas,
- low population density, and
- low level of EEE consumption,

are unable to reach either the collection target mentioned in the first subparagraph of Article 5(5) or the recovery targets mentioned in Article 7(2) and which, under the third subparagraph of Article 5(2) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, may apply for an extension of the deadline mentioned in that Article, may extend the periods referred to in Articles 5(5) and 7(2) of this Directive by up to 24 months. These Member States shall inform the Commission of their Decisions at the latest at the time of transposition of this Directive.

(b) The Commission shall inform other Member States and the European Parliament of these decisions.

5. Within five years after the entry into force of this Directive, the Commission shall submit a report to the European Parliament and the Council based on the experience of the application of this Directive, in particular as regards separate collection, treatment, recovery and financing systems. Furthermore the report shall be based on the development of the state of technology, experience gained, environmental requirements and the functioning of the internal market. The report shall, as appropriate, be accompanied by proposals for revision of the relevant provisions of this Directive.

Article 18

Entry into force

This Directive shall enter into force on the day of its publication in the *Official Journal of the European Union*.

Article 19

Addressees

This Directive is addressed to the Member States.

Done at Brussels, 27 January 2003.

For the European Parliament

The President

P. COX

For the Council

The President

G. DRYS

APPENDIX B

Composition of a Desktop Personal Computer Based on a typical desktop computer, weighing ~60 lbs.				
Name	Content (% of total weight)	Weight of material in computer (lbs.)	Recycling Efficiency (current recyclability)	Use/Location
Aluminum	14.1723	8.5	80%	Structural, conductivity/housing, CRT, PWB, connectors
Antimony	0.0094	< 0.1	0%	Diodes/housing, PWB, CRT
Arsenic	0.0013	< 0.1	0%	Doping agents in transistors/PWB
Barium	0.0315	< 0.1	0%	In vacuum tube/CRT
Beryllium	0.0157	< 0.1	0%	Thermal conductivity/PWB, connectors
Bismuth	0.0063	< 0.1	0%	Wetting agent in thick film/PWB
Cadmium	0.0094	< 0.1	0%	Battery, glu-green phosphor emitter/housing, PWB, CRT
Chromium	0.0063	< 0.1	0%	Decorative, hardener/(steel) housing
Cobalt	0.0157	< 0.1	85%	Structural, magnetivity/(steel) housing, CRT, PWB
Copper	6.9287	4.2	90%	Conductivity/CRT, PWB, connectors
Europium	0.0002	< 0.1	0%	Phosphor activator/PWB
Gallium	0.0013	< 0.1	0%	Semiconductor/PWB
Germanium	0.0016	< 0.1	0%	Semiconductor/PWB

Gold	0.0016	< 0.1	99%	Connectivity, conductivity/PWB, connectors
Indium	0.0016	< 0.1	60%	transistor, rectifiers/PWB
Iron	20.4712	12.3	80%	Structural, magnetivity/(steel) housing, CRT, PWB
Lead	6.2988	3.8	5%	Metal joining, radiation shield/CRT, PWB
Manganese	0.0315	< 0.1	0%	Structural, magnetivity/(steel) housing, CRT, PWB
Mercury	0.0022	< 0.1	0%	Batteries, switches/housing, PWB
Nickel	0.8503	0.51	80%	Structural, magnetivity/(steel) housing, CRT, PWB
Niobium	0.0002	< 0.1	0%	Welding allow/housing
Palladium	0.0003	< 0.1	95%	Connectivity, conductivity/PWB, connectors
Plastics	22.9907	13.8	20%	Includes organics, oxides other than silica
Platinum	0		95%	Thick film conductor/PWB
Rhodium	0		50%	Thick film conductor/PWB
Ruthenium	0.0016	< 0.1	80%	Resistive circuit/PWB
Selenium	0.0016	0.00096	70%	Rectifiers/PWB
Silica	24.8803	15	0%	Glass, solid state devices/CRT,PWB
Silver	0.0189	< 0.1	98%	Conductivity/PWB,

				connectors
Tantalum	0.0157	< 0.1	0%	Capacitors/PWB, power supply
Terbium	0	0	0%	Green phosphor activator, dopant/CRT, PWB
Tin	1.0078	0.6	70%	Metal joining/PWB, CRT
Titanium	0.0157	< 0.1	0%	Pigment, alloying agent/(aluminum) housing
Vanadium	0.0002	< 0.1	0%	Red phosphor emitter/CRT
Yttrium	0.0002	< 0.1	0%	Red phosphor emitter/CRT
Zinc	2.2046	1.32	60%	Battery, phosphor emitter/PWB, CRT

Table presented in: Microelectronics and Computer Technology Corporation (MCC). 1996. Electronics Industry Environmental Roadmap. Austin, TX: MCC.

Note: plastics contain polyBrominated Flame-retardants, and hundreds of additives and stabilizers not listed separately.

APPENDIX C

<u>National Recycling Rates</u>

NATION	RECYCLING RATE	TARGET RATE
SWITZERLAND	52% in 1998	
NETHERLANDS	46% in 1998	60%by 2000
AUSTRIA	48% in 1996	
GERMANY	48% in1996	
NORWAY	38% in 1999	
SWEDEN	34% in 1997	
USA	31.5% in 1998	35% by 2005
FINLAND	30% in 1997	
CANADA	29% in 1997	
DENMARK	31% in 1996	40-50%by 2000
FRANCE	12% in 1993	
SPAIN	20% in 1997	
ENGLAND and WALES	9% in 1998/9	30% by 2010
SCOTLAND	5.7%	

<http://www.foe.co.uk/pubsinfo/infoteam/pressrel/2001/20010122000133.html>

APPENDIX D

EU Member State Recycling & Recovery targets

By December 31st 2005 member states must reach the following targets:-

<u>Category of WEEE</u>	Rate of Recovery (%)	Rate of Recycling (%)
Large household appliances	90	75
Small household appliances	80	50
IT & Telecommunication equipment	85	65
Consumer equipment	85	65
Lighting equipment	80	50
Electrical & electronic tools	80	50
Toys	80	50
Medical equipment systems (with the exception of all implanted and infected products)	N/A	N/A
Monitoring & control instruments	80	0
Automatic dispensers	80	50

These targets are also likely to be revised post 2008, and there is a requirement for Member States to provide data on recycling and recovery of waste electrical and electronic goods. It is important to note that these targets will only apply to separately collected WEEE.

<http://www.wasteonline.org.uk/resources/Legislation/WEEE.html>