EXTENDED PRODUCT RESPONSIBILITY:
A NEW PRINCIPLE FOR PRODUCT-ORIENTED POLLUTION PREVENTION

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PREFACE AND ACKNOWLEDGMENTS

Extended Product Responsibility (EPR) has been the focus of the policy research of the Center for Clean Products and Clean Technologies for the past four years. In November 1994 the Center hosted the first U.S. symposium on EPR held in Washington, D.C., which brought together researchers and policy analysts to discuss how EPR, which has emerged in the European context, might apply in the United States. In 1995 the President's Council on Sustainable Development (PCSD) took up the issue and went on to endorse the general principle of Extended Product Responsibility and to recommend adoption of a voluntary system of EPR.

The U.S. Environmental Protection Agency's Office of Solid Waste has been supporting the EPR research of the Center for Clean Products for the past two years and has been cooperating in evaluating and presenting the findings of this research. The focus of this report is on the implementation of EPR by U.S. companies. What has been striking to us and our EPA sponsors from the beginning of this research is the degree to which U.S. companies have been implementing EPR without government mandates. We believe that this finding and the case studies contained in the report are important news for the business community. The report showcases successful applications of EPR by U.S. companies responding to a variety of business drivers, including cost savings, increased customer loyalty, product innovation, and green image building. These case studies are presented to encourage other companies to consider voluntary adoption of EPR as a business strategy.

The case studies in the report were chosen based upon our awareness of company EPR initiatives through literature reports and through the extensive network of contacts of the Center for Clean Products and our collaborators in this project. We have also included other case studies that surfaced through the planning for the President's Council on Sustainable Development workshop mentioned below. We attempted to reflect examples from a variety of industry sectors and which included a variety of methods of implementing EPR. There are undoubtedly more examples that would have merited inclusion in this report, and the exclusion of any example does not imply lack of merit. We will continue to collect information about other examples and will look for opportunities to make additional case studies widely available. We believe that the publication of as many case studies as possible will further the understanding and practice of EPR.

Besides introducing the general principle of EPR to a broader audience, this report briefly highlights a few of the more innovative policy initiatives from other countries. The reader should keep in mind that EPR-based policies are evolving rapidly in Europe and Japan, so that any discussion of these policies will inevitably be a snapshot of the situation at the time the research is done. The Center has prepared detailed discussions of EPR policies in Europe, Canada, and Japan, which will be published separately.

As a way of furthering the ongoing discussion about EPR in the United States, the EPA Office of Solid Waste and the President's Council on Sustainable Development co-sponsored a workshop held in October 1996 that brought together industry representatives with government officials, environmental group representatives, and academic researchers. Many of the companies showcased in this report made brief presentations about their implementation of EPR at the workshop. A proceedings has been published from that workshop, which is available through the PCSD and the EPA Office of Solid Waste.

EPR is certain to gain more visibility in the coming months. The Organization for Economic Cooperation and Development has been preparing reports on specific EPR issues and will begin conducting a series of international workshops this winter. Major new legislation is taking effect in Europe and Japan, and product systems other than packaging are being impacted. The Center for Clean Products will continue to follow these developments and participate with EPA in evaluating and disseminating information about EPR.

The Center wishes to especially thank Clare Lindsay of EPA's Office of Solid Waste for her leadership and for her support for our research and thoughtful input in the development of this report. Special acknowledgment is also due Jack Barkenbus, Executive Director of the University of Tennessee Energy, Environment and Resources Center, who supported the EPR research by the Center for Clean Products before it could be funded by EPA. Bette Fishbein with INFORM and Patty Dillon of the Gordon Institute at Tufts University were valuable collaborators for this report and also deserve acknowledgment for their ongoing research on EPR policies and the implementation of EPR by U.S. companies. We also want to acknowledge Danielle Droitsch, Richard Thornburg and Christine Dummer, students in the University of Tennessee College of Law who prepared detailed background reports of EPR policies in Europe, Canada, and Japan. Last, but not least, we acknowledge the invaluable assistance of Margaret Goergen, administrative assistant in the Center for Clean Products, who was responsible for document production.

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CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1 THE GENERAL PRINCIPLE OF EXTENDED PRODUCT RESPONSIBILITY

Extended Product Responsibility ("EPR") is an emerging principle for a new generation of pollution prevention policies that focus on product systems instead of production facilities. The principle of Extended Product Responsibility relies for its implementation upon the life-cycle concept to identify opportunities to prevent pollution and reduce resource and energy use in each stage of the product life cycle (or product chain) through changes in product design and process technology.

Extended Product Responsibility is the principle that the actors along the product chain share responsibility for the life-cycle environmental impacts of the whole product system, including upstream impacts inherent in the selection of materials for the products, impacts from the manufacturer's production process itself, and downstream impacts from the use and disposal of the products. The greater the ability of the actor to influence the life-cycle impacts of the product system, the greater the degree of responsibility for addressing those impacts should be. Producers, for instance, accept their responsibility when they design their products to minimize the life-cycle environmental impacts and when they accept their share of the physical or economic responsibility for the environmental impacts that cannot be eliminated by design.

The principle of Extended Product Responsibility is an outgrowth and modification of the term Extended <u>Producer</u> Responsibility, which has been used to describe the German Packaging Ordinance and other European policies that are discussed briefly in this chapter.[1] In reality, most of the policies for extension of responsibility for product systems do not place the entire onus on the producer, but result in some type of shared responsibility. The German Packaging Ordinance, for instance, is a system of shared responsibility among the retailers of packaged products, the producers of packaging, and consumers. The term Extended <u>Product</u> Responsibility has gained greater acceptance in the United States because it implies shared responsibilities in the product chain, although often the producer is in the best position, both technically and economically, to influence the rest of the product chain in reducing life-cycle environmental impacts.

There are three key attributes of Extended Product Responsibility that are examined in this report: 1) the extension or shifting of responsibility to a life-cycle stage or stages where responsibility currently does not exist or is not well-defined; 2) a product systems approach with a focus on creating feedback to product designers to design cleaner products; and 3) sharing of responsibility for the life-cycle environmental impacts of the product system among links in the product chain in such a way that there is a well-defined locus of responsibility, which may include more than one link.

1.2 THE PRODUCT CHAIN AND THE CURRENT ENVIRONMENTAL RESPONSIBILITY PARADIGM

The product chain is the life cycle of a product. The product chain begins with the extraction of raw materials and progresses through manufacturing of the product to product use and ultimate disposal. The Dutch, for instance, use this product chain or life-cycle concept to talk about Extended Product Responsibility and call the process of implementing EPR "Integrated Chain Management."[2] Throughout the product chain, there are inputs of resources and energy and outputs of pollutants (air, water, solid and hazardous waste), in addition to the production of products of commercial interest.

Over twenty years of environmental regulations have focussed on controlling the pollution outputs from individual firms within the product chain without regard to the linkages to other stages of the product chain. Under this limited view of environmental responsibility, solid waste management, for instance, has been the responsibility of the individual householder or the local government acting on his or her behalf. Traditionally, the producer of the disposable product packaged in multiple layers of non-recyclable packaging has not been viewed as having any responsibility for the product or package when they become waste. As solid waste burdens have increased and tightening disposal regulations have made solid waste management more expensive, the budgets of local governments have been stretched thin, and local taxes have been increased. At the same time, the siting of solid waste facilities has become a major political battleground. Local governments have been saddled with the responsibility for a problem that is not of their own making and about which they can do little on their own to prevent.

The design of products and product systems is the most critical step in determining the nature and quantity of resource and energy use and pollution outputs throughout the products' life cycles. This is why EPR seeks to create an effective feedback loop to product designers to encourage them to design cleaner products. In addition to determining the impacts of the actual manufacturing process for the product, the choice of materials, for instance, determines the environmental impacts upstream in the extraction and processing of raw materials. Material selection also determines the downstream impacts during the use stage and in the ultimate disposal of the product. The product producer can, at the design step in product development, make a tremendous contribution to minimizing solid waste generation and the impacts of solid waste management.

But when producers design products so as to use less material, to extend product life or to be recyclable, the users of the products and the waste management sector must also share responsibility for sorting, collection, recycling, and proper disposal. Also, users of products must take responsibility for carefully choosing recycled and recyclable products and for generating less waste in the first place by buying less or finding reuse or repair options for products that they no longer use.

Because it has not been common for producers to take responsibility for the upstream or downstream environmental impacts of their products, these environmental impacts have rarely entered into their design strategies. At the same time, retailers and consumers typically do not take the environment into account in their product selections and in their management of end-of-life products and packaging. The principle of Extended Product Responsibility seeks to extend responsibility up and down the chain so each actor in the chain has appropriate incentives to be concerned about the life-cycle environmental impacts of the whole product system.

Some producers, driven by a new consumer consciousness of the environmental impacts of product choices and by a desire to reduce environmental costs and avoid more stringent regulations, have picked up on the need for extending their responsibility over the entire product chain, long before any government policies have been developed to mandate them to do so. Very rapidly, the focus for these firms has shifted to cleaner products. Design-for-the-Environment, industrial ecology, life-cycle design, and safe substitutes have become business strategies among a growing number of producers. These producers have voluntarily accepted the extension of their environmental responsibility. The case studies in Chapters 3 - 8 of this report speak to the motivations of these producers and the examples that they have set for the voluntary implementation of the principle of Extended Product Responsibility.

1.3 DEVELOPMENT OF POLICIES FOR EXTENDING PRODUCT RESPONSIBILITY

To implement Extended Product Responsibility fully requires incentives up and down the product chain so that each actor is concerned about and exercises appropriate measures to reduce the life-cycle environmental impacts of the whole product system. Although some producers and distributors have voluntarily accepted greater responsibility, government policies can provide additional incentives. Governments can extend product responsibility through a variety of policy measures, which differ significantly from past pollution prevention policies that have focussed on production facilities.

To date, the implementation of policies that have Extended Product Responsibility as their explicit underpinning has occurred mostly in Western Europe. The most visible such government policy embodying the principle has been the mandatory take-back approach of the German Packaging Ordinance. It should be emphasized, however, that the principle of Extended Product Responsibility embodied in this report is far broader and incorporates many other types of policy measures than the mandatory take-back and rigid recycling goals that are the hallmarks of the German Packaging Ordinance.

Other policies for specific products or specific waste streams that encourage responsibility for the life-cycle environmental impacts of products, both upstream and downstream, have existed for several years. One of the first widely-adopted examples of Extended Product Responsibility is the deposit-refund system for beverage packaging that has been in effect in many countries for more than thirty years. The energy crisis of the 1970s, the hazardous waste crisis of the 1980s, and concerns about solid waste management in the 1990s have engendered EPR-based policies that impact specific product chains, such as energy efficiency labeling for appliances, chemical bans and phase-outs, and packaging recycling initiatives. Other policies related to Extended Product Responsibility include environmental procurement programs, minimum recycled content requirements, advance disposal fees, materials restrictions, product taxes, materials use regulations, and voluntary partnerships with government and others to bring about changes in product design and end-of-life materials management so as to reduce the life-cycle impacts of products.

1.3.1 Packaging and EPR

Packaging waste has been the major target of EPR in Western Europe. In recent years, the policy initiative that has created the most discussion about the EPR principle is the German Packaging Ordinance of 1991, which is an ambitious program for collecting and recycling consumer product packaging to reduce the demand on scarce disposal capacity in Germany. The Ordinance places initial responsibility on distributors (retailers) of packaged consumer goods to take back the packaging for recycling, but allows retailers to avoid the direct take-back obligation for packaging that is managed by the packaging-producer-funded collection and recycling system, Duales System Deutschland (DSD or Dual System Germany). The DSD was initiated in 1990 as a separate private system (separate from the municipal waste management systems) for collecting and recycling packaging. The system is financed by fees on packaging paid for by packaging producers. Producers who pay the fees to fund the system are entitled to label their packaging with a green dot that tells retailers and consumers that the packaging will be collected and managed by the DSD. The German Packaging Ordinance also requires take back of transport packaging.

The Packaging Ordinance has been very controversial, primarily because it also contains aggressive recycling quotas, which were imposed before adequate recycling capacity existed in Germany. The Ordinance was recently modified, because the overly ambitious recycling targets in the original ordinance could not be met, because of the costs associated with the original plan, and because of the problem of “free riders”— packaging producers whose packaging is collected and managed by DSD but who have not paid any fees. While the take-back obligation was not changed, the amended Ordinance now allows for incineration with energy recovery to satisfy part of the recycling quotas.

Instead of mandating take back, the Netherlands has used a negotiated agreement or “covenant” approach to commit packaging producers, packaging fillers, retailers of consumer products, and waste handlers to EPR. The Packaging covenant was signed in 1991 by an association representing each of the links in the packaging chain and by three ministries in the Dutch government. The covenant contains a general goal of eliminating landfilling of packaging waste by the year 2000.[3] It also contains a source reduction goal, a goal of removing harmful materials from packaging, and packaging reuse and materials recycling goals. The recycling goals do not provide for incineration with energy recovery as a recycling option and instead implement the hierarchy of reuse first, then materials recycling.[4] Life-cycle assessments and market-economic analyses of packaging alternatives have been sponsored by the Dutch government to help steer the packaging chain toward the best alternatives to achieve the goals of the covenant.

France has also followed an EPR approach for packaging waste without the stringent material recycling quotas of Germany and without displacing local governments in the collection of packaging waste. The Waste Act, adopted in 1992, gave producers and distributors three options to accept responsibility for the management of packaging waste from their products. First, firms could organize their own deposit and refund system for packaging waste. Second, firms could organize their own separate collection and management systems for packaging waste. Third, firms could choose to contribute to a government-approved organization in charge of funding the costs of separate collection and management systems to be operated by local governments.[5] With the encouragement of the government, most producers and distributors have chosen the third option, under which Eco-Emballages, a quasi-governmental company, was founded. Eco-Emballages collects a fee from packaging producers to pay for the sorting of packaging waste that has been collected by the municipalities. The municipalities still are in charge of waste collection.[6] The French program has focussed on avoidance of landfilling and permits incineration with energy recovery as a recycling technology.

In recognition of the potential for market disruptions with divergent packaging waste laws in different countries, the European Union took up the packaging waste issue in 1992 and adopted the Packaging Directive in 1994.[7] Although the Directive incorporates recycling quotas for packaging, which include incineration with energy recovery, it does not incorporate EPR. It is up to the member countries how to provide incentives to the packaging product chain to meet the quotas.

In order to establish a system that meets the quotas of the EU Packaging Directive, the United Kingdom focussed on allocating responsibility for packaging waste explicitly among links in the product chain. After consideration of alternatives ranging from a purely voluntary approach to take-back or deposit-refund schemes, the government adopted a “shared approach” that offers a choice to businesses to comply individually with the program’s targets or join VALPAK, a shared product responsibility organization set up by businesses in the packaging chain.[8] The obligation of each individual business sector (described below) to finance the packaging collection and recycling scheme differs depending on their position in the packaging chain as follows:[9]

Packaging raw material manufacturing	6 percent
Packaging converting	11 percent
Packaging/filling	36 percent
Selling (retailing)	47 percent

Japan has also recently begun implementing new legislation on food and beverage packaging waste which requires food and beverage producers and packaging producers to set up systems for recycling packaging materials. The legislation initially applies to cans, glass bottles, and polyethylene terephthalate bottles. Municipalities will collect and sort the packaging, and independent recycling corporations funded by the producers will recycle the packaging.

1.3.2 Take-Back Approaches for Other Products

Take-back approaches are also being implemented in Europe for other product systems, including automobiles and electronics goods. Many of the same countries who were leaders in applying EPR to packaging have also been leaders for other products. German legislative proposals on automobiles and electronic goods have led to similar proposals in other countries and by the European Union. In some cases, take back and increased recycling goals are being implemented through negotiated agreements with the affected product chain without passage of legislation.

Automobile take-back and increased recycling are being implemented in Germany, the Netherlands, Sweden, and France. The European Union has also issued a draft directive. The draft German Scrap Car Rule, first proposed on the heels of the Packaging Ordinance, was recently supplanted by a "voluntary pledge" in which the automobile producers agreed to take back end-of-life vehicles without any cost to the final owner. The "voluntary pledge" also commits to an increase in recycling so that the amount of automobile shredder residue for disposal is reduced from the present average of 25 percent by weight of the car to a maximum of 15 percent by weight by the year 2002, decreasing to a maximum of 5 percent by weight by 2015.[10] The pledge does allow the use of incineration with energy recovery as a reduction option.

In contrast to the German Packaging Ordinance, the German automobile take-back program does not set up a new organization to collect and manage end-of-life vehicles, instead relying on and upgrading the existing recycling infrastructure. The Dutch, on the other hand, in setting up a covenant for take back of automobiles, created a new organization to pay for the collection and recycling through a fee on new automobiles.

The European Commission has recently developed a draft directive on end-of-life vehicle waste that is under review. The new draft directive, dated July 31, 1996, incorporates a free take-back requirement, minimum recycling and recovery quotas (85 percent of the weight recycled by 2002, with 95 percent for new models; 95 percent of the weight recycled by 2015 for all models, without counting incineration with energy recovery), and restrictions on certain materials (lead, mercury, cadmium, hexavalent chromium, and PVC).

There have been several legislative proposals for mandatory take back for electronic goods and a resulting scramble for development of voluntary agreements. In 1992 the German government introduced the "Ordinance on the Avoidance, Reduction and Salvage of Waste from Used Electrical and Electronic Equipment." The draft ordinance did not include specific recovery or recycling targets for products, but it did require manufacturers to design more recyclable products and either establish reverse logistics systems for their recovery or finance a private system for the collection, sorting, disassembly, and recovery of used equipment.[11] Since the introduction of the draft ordinance, discussions have been underway between the German Environment Ministry and electronics manufacturers on developing a voluntary framework for the recycling of electronic and electrical products. Similar legislative proposals have been made in Sweden and Austria, and voluntary agreements are being negotiated in the Netherlands, Denmark, and France.[12]

1.3.3 Comprehensive Legislative Frameworks for EPR

Recently, three Western European governments have begun the process of developing a comprehensive framework for Extended Product Responsibility: Germany, the Netherlands, and Sweden. The German Eco-Cycle Waste Act of 1994 imposes a general "product responsibility" on product designers, producers, distributors and users to design, produce, distribute, and use products so as to avoid the creation of waste and to recover and manage waste in an environmentally sound manner. Elements of Extended Product Responsibility listed in the framework legislation include development and manufacture of products which can be reused or have a long life, use of secondary materials for production, labeling of dangerous materials in order to ensure safe waste management, labeling of products as to their reuse and recyclability, and the obligation to take back products after their useful lives. The Act also permits the recovery of wastes based on the "highest value" basis, which allows burning for energy recovery in some instances. The Act does not necessarily represent a complete life-cycle framework for Extended Product Responsibility, since it does not explicitly extend responsibility to include other stages of the product life cycle, such as raw material extraction, transportation impacts, and energy use.

The Netherlands, which has previously implemented take-back approaches through covenants with producers, developed a comprehensive product policy that was approved by the Parliament in late 1993 and which embodies the Extended Product Responsibility principle. It aims to encourage each link in the product chain to take greater environmental responsibility primarily by requiring the distribution of life-cycle assessment information all along the product chain and, ultimately, to the consumer. The driver for development of cleaner products will ultimately come from the marketplace under the Dutch product policy.

The Swedish government adopted the Eco-Cycle Law, effective January 1, 1994, which also embodies the principle of Extended Product Responsibility. It calls for more efficient use of resources in production, recovery, and re-use of waste. The bill identifies packaging as one of the areas to which the principle of EPR may be applied and identifies other product categories, including electronics and electrical appliances, automobiles, tires, and plastics. The bill, much like the German Eco-Cycle Act and the Dutch Product Policy, must be implemented by specific ordinances that contain the details of how Extended Product Responsibility is to be applied.

1.3.4 EPR in the OECD

Following adoption of comprehensive frameworks for EPR in European countries, the Organization for Economic Cooperation and Development (OECD) has become more involved in elucidating the principle and promoting its application. At the International Waste Minimization Workshop in March 1995, Extended Producer Responsibility was adopted as both a basic principle and key strategy for waste minimization. Further, members of the Pollution Prevention and Control Group and the Waste Management Policy Group expressed considerable interest in continued analysis of Extended Producer Responsibility as a tool for waste minimization contributing to a strong product policy.

To this end, the OECD is in the process of completing three phases of research on Extended Producer Responsibility. Phase 1 consisted of a report, published in March 1996, cataloging EPR programs in OECD countries.[13] Phase 2, portions of which are still underway, consists of several study themes, including case studies of trade implications, methods for analysis of cost-effectiveness of Extended Producer Responsibility methods, and legal issues affecting Extended Producer Responsibility implementation. Phase 3, to be completed in 1999, will consist of a series of workshops involving different stakeholders. These workshops will encourage dialogue on more fully defining Extended Producer Responsibility and recommending policy approaches to implement Extended Producer Responsibility programs. The specific goals of these workshops will be:

- To propose policy options aimed at minimizing pollution, wastes and natural resource consumption throughout the life cycle of the product.
- Suggest efficient and equitable means to prevent producers from transferring the costs for dealing with pollutants and wastes of product systems to other links in the product chain that are least capable of preventing these external costs.
- Help promote the application of the Polluter Pays Principle by developing proposals to ensure that the private sector is responsible for efforts to reduce environmental effects from both use and discarding of their products and to use recovered resources, recycling, and reclaimed materials in so doing.[14]

1.4 TOWARD A BROADER VISION OF EPR POLICIES

The purpose of the policy discussion in this chapter is not to advocate the adoption of any specific Extended Product Responsibility policies in the United States, but to show the development of these policies throughout the world and their potential influence on the situation in the United States. It is unlikely that any one policy option will result in widespread implementation of Extended Product Responsibility or will be appropriate for the conditions (political and economic) in every country. As discussed in Chapter 2, the federal government in the United States and several state governments already have policies in place that encourage Extended Product Responsibility, at least indirectly. Policy makers at all levels are struggling with the appropriate mix of policies and are experimenting with innovative voluntary approaches with willing partners in the producer community.

Many of these new policy options, being voluntary or market-driven, encourage a more cooperative, outcome-oriented relationship among government and the actors along the product chain than traditional command-and-control regulations. These options also allow more flexibility for producers in achieving environmental goals, encouraging innovation, since they do not necessarily prescribe technologies.

The President's Council on Sustainable Development recently concluded "that sharing responsibility for environmental effects would transform the marketplace into one driven by:

- More efficient use of resources.
- Cleaner products and technologies.
- More efficient and more competitive manufacturing.
- Safer storage, shipping, and handling of materials.
- Improved relations between communities and companies.
- Improved recycling and recovery.
- Responsible consumer choices."[15]

With this potential, Extended Product Responsibility can be a key principle that leads from facility-oriented pollution prevention to environmentally and economically sustainable production and consumption.

ENDNOTES

1. The phrase “Extended Producer Responsibility” was first used by Thomas Lindhqvist, Lund University, Department of Industrial Environmental Economics. See proceedings, *Extended Producer Responsibility as a Strategy for Cleaner Products.* 1992. Invitational Expert Seminar, Department of Industrial Environmental Economics, Lund University, Sweden, May 4-5.

2. *Integrated Substance Chain Management.* 1991. Dutch Ministry for Housing, Physical Planning, and the Environment.

3. *Inventory of Product Policy Instruments.* 1993. Institute for Environmental Studies, Free University. Amsterdam. November.

4. *Packaging Covenant*. 1991. Ministry of Housing, Physical Planning, and the Environment. The Netherlands. June 6.

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6. Demetrakakes, P. 1993. “European Packaging Laws: A Pandora’s Box.” *Packaging*. February.

7. *European Parliament and Council Directive on Packaging and Packaging Waste.* 94/62/EC.

8. *The Producer Responsibility Obligations (Packaging Waste) Regulation: A Consultation Paper.* 1996. UK Department of the Environment. July, § 1.12, 1.24.

9. *The Producer Responsibility Obligations (Packaging Waste) Regulation: A Consultation Paper.* 1996. Department of the Environment. July, § 4.2 - 4.5.

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11. Dillon, Patricia. 1994. “Electronics Recycling Legislation in Europe and Its Implications for U.S. Public Policy. *In Extended Product Responsibility: A New Principle for New Generation of Pollution Prevention* (C. Wilt and G. Davis, eds). University of Tennessee Center for Clean Products and Clean Technologies.

12. Davis, John Bremer. 1996. “Product Stewardship and the Coming Age of Takeback. What Your Company Can Learn from the Electronic Industry’s Experience.” *Business and the Environment*. Cutter Information Corporation. p. 13-32.

13. Organisation for Economic Co-Operation and Development. *Pollution Prevention and Control. Extended Producer Responsibility in the OECD Area*. Phase 1 Report. 1996. OECD Environment Monographs, No. 114. Paris. OECD/GD(96)48.

14. Organisation for Economic Co-Operation and Development, Environmental Policy Committee, Group on Pollution Prevention and Control. 1996. *Extended Producer Responsibility*, ENV/EPOC/PPC(96)5, May 13-14.

15. *Sustainable America: A New Consensus*. 1996. President's Council on Sustainable Development. p. 39.

CHAPTER 2

EXTENDED PRODUCT RESPONSIBILITY IN THE UNITED STATES

2.1 HISTORICAL CONTEXT

Although the U.S. has no comprehensive Extended Product Responsibility law or policy, there are laws and policies at the federal level that indirectly embody the principle and have been applied to particular environmental problems. In the 1970s, an energy crisis stimulated programs, such as mandatory energy efficiency labeling for appliances, to increase consumer awareness of energy consumption and to promote products that conserve electricity. Hazardous waste problems became apparent in the 1980s, leading to product and materials policies such as chemical bans and phase-outs. The 1990s have given rise to increased concerns about solid waste generation and disposal, especially as many landfills near capacity and new sites face stiff public opposition. This concern over solid waste has led to increased interest in engaging product producers in the process of reducing and managing the wastes created by their products.

Recently, increased demand from consumers for “green products” has caused many companies to reevaluate their products’ design, production, recyclability, and disposal. Some states and the federal government have responded to public pressure with new legislation or voluntary programs aimed at altering consumer and producer behavior. These pressures have combined with the regulatory initiatives in Western Europe, which directly affect U.S. exporters, to heighten awareness of EPR and its implications in the U.S. Furthermore, as companies begin to take more responsibility for the life cycle of their products, they are discovering business advantages, including reduced environmental costs and liabilities and reduced raw materials costs. This heightened awareness of EPR in the U.S. led to the President’s Council on Sustainable Development recommendation that EPR be implemented in the U.S. through a voluntary program and, in one specific case, caused one industry to support federal legislation facilitating a producer-sponsored take-back and recycling program.

2.2 RECENT EPR INITIATIVES ON THE FEDERAL LEVEL

2.2.1 President’s Council on Sustainable Development

In 1993 The President’s Council on Sustainable Development (PCSD) was created to advise the President on integrating the environmental, economic, and social goals of the nation so that the needs of the present can be met without compromising the ability of future generations to meet their own needs. The PCSD was composed of leaders from government, business, environmental, civil rights, labor, and Native American organizations. One of the major policy recommendations of the PCSD is that the nation should “adopt a voluntary system that ensures responsibility for the environmental effects throughout a product’s life cycle by all those involved in the life cycle.”[1]

Specifically, the PCSD recommended in 1996 that the President should appoint a Product Responsibility Panel to facilitate voluntary, multi-stakeholder models of shared product responsibility through demonstration projects. The Product Responsibility Panel would include representatives from all sectors; the demonstrations would help identify means of conducting effective monitoring, evaluation, and analysis of the project's progress and possible links with other sustainable development initiatives. It would also help coordinate sound economic and environmental analyses to assist in transferring the lessons from local demonstration projects to regional and national policies. The panel would have a balanced representation of stakeholders with interests in the life cycle of a product, including its supply, procurement, consumption, and disposal.

The PCSD further recommended that, following evaluation of the demonstration projects, the federal government, private companies, and individuals should voluntarily adopt practices and policies that have been successfully demonstrated to carry out EPR on a regional and national scale. After the demonstrations, the Product Responsibility Panel would also recommend any legislative changes needed to remove barriers to extending product responsibility. Finally, the PCSD recommended that the procurement policies of federal, state, local, and tribal governments should reflect preferences for resulting cost-effective, environmentally superior products.[2]

In October 1996, the PCSD and EPA co-sponsored a workshop on EPR in Washington, D.C., at the White House Conference Center. Workshop participants included over 85 persons from numerous businesses, trade associations, environmental groups, states, universities, and the federal government.

A major goal of the workshop was to showcase some of the business initiatives already underway in the U.S. that illustrate EPR in action. U.S. companies are beginning to embrace the principle of EPR for a variety of reasons: some are responding to mandates abroad; some wish to forestall similar mandates in the U.S.; some are striving to meet corporate goals to "green" their products; and some recognize that products can be valuable assets even at the end of their useful life. Other goals of the workshop were to: 1) enhance understanding of the principles of EPR; 2) demonstrate the various models, actors and industry sectors implementing EPR through presentation of case studies; 3) determine how best to educate the business community, government, environmental organizations, and other non-governmental organizations about the benefits and challenges of EPR; and 4) encourage greater implementation of EPR.

The workshop program included introductory presentations on the concept of EPR and the drivers and obstacles facing businesses and other organizations interested in EPR. Eleven companies, including many of those represented in this report, presented case studies on how they are implementing EPR to reduce the life-cycle environmental impacts of their products. Some of the presentations included partners (such as suppliers, product users, trade associations) in the product life cycle who are helping to make EPR successful. Industry sectors represented in the case studies included the automobile, forest products, consumer products, building cleaning and maintenance, plastics, telecommunications, office equipment, battery, and carpeting industries. In total, more than 30 companies and industry associations participated in the workshop.

Among the findings of the workshop were that EPR is actively being implemented in the U.S., and is bringing about significant changes in products and their associated environmental impacts. In many cases, changes are occurring at multiple stages in product life cycles: upstream, during manufacturing; during product use; and at the end of the product's useful life. Though EPR is not yet a standard way of doing business in the U.S., the participants agreed that the idea must spread to more products and players in this country.[3]

2.2.2 Mercury-Containing and Rechargeable Battery Management Act

The Mercury-Containing and Rechargeable Battery Management Act signed by the President on May 13, 1996, helped usher in a voluntary, national take-back system for nickel-cadmium rechargeable batteries. The primary purpose of this law, which was actively sought by the rechargeable battery industry, is to facilitate a national take-back program paid for and carried out by the rechargeable nickel-cadmium battery and rechargeable products industries to collect and recycle these batteries. The law paves the way for the national collection and recycling of these batteries by making a new regulation immediately applicable nationwide that eases what would otherwise be more onerous regulatory requirements for collection and recycling of these batteries. The Act also requires uniform national labeling of nickel-cadmium and other rechargeable batteries and sets uniform battery removeability design requirements for rechargeable products containing these batteries. Chapter 6 describes the battery take-back and recycling system in detail.

2.3 POLICIES ON THE FEDERAL LEVEL THAT EMBODY THE EPR PRINCIPLE

Following is a brief description of types of policies that embody the principle of EPR which have been implemented or are under consideration at the federal level in the U.S. Such policies tend to encourage EPR directly, if not explicitly, when they deal with environmental impacts beyond those associated with an individual manufacturing facility in the product chain.

- **Partnering Agreements** - Pollution prevention goals and measures agreed to among the federal government and other stakeholders in the product chain, such as the EPA WasteWi$e Program and the EPA Green Lights Program.
- **Voluntary Product Environmental Information Approaches** - Voluntary approaches in which producers provide information on the significant environmental attributes of products so that purchasers can reflect environmental preferences in their purchasing decisions. The EPA Energy Star Program is an example of such a program.
- **Government Procurement of Recycled-Content Products and Environmentally Preferable Products and Materials** - In addition to price and quality, government purchasing is directed at products that contain recycled content or are considered "environmentally preferable." Executive Order 12873 (1993) requires Federal agencies to purchase recycled content and other "environmentally preferable" products. EPA identifies recycled content products and provides guidance on purchasing them. EPA also provides general guidance on purchasing "environmentally preferable" products.

- **Mandatory Disclosure of Environmental Information** - Requirements that producers or distributors provide information about the environmental attributes of a product. One example includes appliance energy efficiency labeling, required by the Energy, Policy and Conservation Act of 1976, which, together with minimum efficiency standards, has been very successful in encouraging manufacturers to increase energy efficiency of large appliances.
- **Mandatory Labeling of Product Contents** - Labeling that provides the user with information about the product contents, which can take two forms: 1) a simple listing of product ingredients; or 2) statements concerning the potential environmental or health impacts of those ingredients. For instance, the Consumer Product Safety Act requires certain products to contain statements of potential health and safety impacts.
- **Materials Regulations/Prohibitions** - Regulations on material use, such as bans of toxic chemicals. An example is the Toxic Substances Control Act, which allows EPA to restrict or prohibit material production, distribution, use, and disposal.

2.4 POLICIES ON THE STATE LEVEL THAT EMBODY THE EPR PRINCIPLE

Following is a brief description of additional types of policies that embody the principle of EPR and which have been implemented or are under consideration at the state level in the U.S.

- **Deposit-Refund Systems** - Mandatory systems in which a deposit is charged to the purchaser at the time of purchase to encourage the return of the product (or packaging) at the end of its useful life, at which time the deposit is refunded. These have been implemented for beverage containers in ten states.
- **Product Taxes to Fund Waste Management Systems** - Taxes that are used to shift economic responsibility for waste management to the producer and consumer of the product that generates the waste, often called advance disposal fees. Examples include taxes on new automobile tires or batteries which are used to fund recycling or disposal systems. More than half the states have advance disposal fees for tires, for instance.
- **Mandatory Product Take Back** - A few states require retailers of lead-acid batteries to accept spent batteries from anyone who brings one in.
- **Waste Disposal Bans** - Most states ban landfilling of certain products or materials, which can lead to increased producer efforts to collect and recycle them. State bans on disposal of nickel-cadmium batteries, for instance, led to the industry-wide take-back and recycling program described in Chapter 6.

2.5 VOLUNTARY EPR INITIATIVES BY PRODUCERS

Several voluntary EPR initiatives have been created by producers in the U.S. Following are some general categories of these programs.

- **Corporate or Industry-Wide Product Stewardship Programs** - Voluntary measures that generally deal with the downstream environmental and safety aspects of product use. An example is the chemical industry's Responsible Care Program, announced by the Chemical Manufacturers Association (CMA) in 1988. This program outlines a standard method for CMA member companies to develop principles, practices, and obligations regarding environmental, health, and safety responsibilities in the management of chemicals.[4] Responsible Care has six elements: 1) Guiding Principles - a statement of the philosophy and commitment by all member companies; 2) Codes of Management Practices in specific areas of chemical manufacturing, transporting, and handling; 3) Public Advisory Panels - leaders from the environmental and health and safety fields who assist the industry in identifying and developing programs and actions that are responsive to public concerns; 4) Member Self-Evaluations - reports, measurements, and other demonstrations of program implementation that document progress toward improved environmental, health, and safety performance in the management of chemicals; 5) Executive Leadership Groups - senior industry representatives who periodically review the Codes of Management Practices being developed, discuss progress on implementing existing codes, and identify areas where assistance from CMA or other companies is needed; and 6) Obligation of Membership - member companies are obligated by the bylaws to ascribe to the Guiding Principles, to participate in the development of the Codes and programs, and to make good-faith efforts to implement the program elements of the Responsible Care initiative.
- **Voluntary Take-Back or Buy-Back Programs -** The producer voluntarily takes back or buys back products or waste materials for recycling or proper management in order to mitigate downstream environmental impacts from product use and to recover valuable materials. The Case Studies dealing with the electronics industry (Hewlett-Packard, Compaq, and Nortel - Chapter 3; Xerox - Chapter 7), the automotive industry (Ford and Saturn - Chapter 5), and the rechargeable battery industry (Chapter 6), provide examples of voluntary take-back or buy-back programs. Others include a new carpet recycling program at BASF which allows customers to send nylon carpet back after its useful life so it can be recycled into other products;[5] a program initiated by New Jersey Bell in 1993 to accept old telephones and answering machines at selected department stores throughout the state, which pays for itself through recovery of valuable materials;[6] and a program by some kayak manufacturers, such as Perception, Inc., to accept used or damaged boats made from a recyclable linear polyethylene to be recycled into seats and bracing components for new kayaks.[7]
- **Leasing Systems** - Voluntary systems in which ownership of durable materials and products is never transferred down the product chain. Instead, the function of the materials or products is leased to the user, at least theoretically encouraging the producer to close material loops and extend product life. An example is a carpet leasing program developed by Interface Flooring Systems in which Interface retains ownership of the commercial carpet, charging a lease fee for installing and maintaining it, replacing worn portions and whole sections when necessary, and recycling the carpet when replaced.[8]

- **Life-Cycle Management Programs** - These include environmental management and auditing programs which are extensions of internal environmental management systems extended upstream (to provide assistance to suppliers) and downstream (to provide assistance to product users in improving their environmental performance). They also include Design-for-the-Environment (DfE) Programs and the use of tools like life-cycle assessment (LCA) to improve the life-cycle environmental performance of a product, often in partnership with suppliers or other stages of the life cycle. The Case Study of the electronics industry (Chapter 3) discusses DfE programs and extended environmental management programs used by Hewlett-Packard, for instance. The Case Study of the automotive industry (Chapter 5) discusses Ford's efforts to incorporate recycled plastics in new car parts. The Rochester Midland Case Study (Chapter 8) highlights an innovative partnership between a cleaning products supplier, a building maintenance company, building owner, and occupants to reformulate cleaning products and reduce impacts of their use. Other examples include IBM's design-for-disassembly program[9] and the supplier accreditation program conducted by The Body Shop, which rates its suppliers based upon their environmental management programs, their waste generation, recycling efforts, and emissions.[10]
- **Partnerships for Recycling and Waste Management** - Companies in the product chain are pooling their resources to create partnerships for recycling and waste management. These may involve separate corporations with membership by many members of the product chain. Rechargeable battery producers, for instance, joined together to form the Rechargeable Battery Recycling Corporation (discussed in detail in Chapter 6), which administers a collection and recycling program and a license and fee system to fund the collection and recycling program. These partnerships may involve cooperative product development. For example, two U.S. textile companies, Martin Color-Fi, Inc. and Starenseir, collaborated to develop a woven fabric called "NatureTex 100," made entirely from post-consumer recycled plastic beverage bottles. These partnerships may also involve life-cycle partnerships, or partnerships among different links in the product chain. For example, photographic film manufacturers have assisted their photographic chemical customers in meeting wastewater discharge standards for precious metals (silver) by including the waste collection and recovery services of Safety-Kleen as part of their overall service to customers, such as minilabs in retail stores, thereby recovering valuable silver for reuse.[11] United Parcel Service (UPS) has partnered with producers of consumer goods, such as Canon, to facilitate the take back of products for recycling by offering an "Authorized Return Service" (ARS) which provides a preprinted label shipped inside the package when a company sends out new stock or products that can be used by the customer as a mailing label to ship the item back for recycling.[12]

2.6 FACTORS ENCOURAGING VOLUNTARY ADOPTION OF EPR

As discussed with the specific Case Studies in Chapters 3 through 8, there are several factors which have encouraged companies in the U.S. to voluntarily adopt EPR. These include (not necessarily in order of importance):

- **Cost Savings** - Even if not created for cost savings, many of the voluntary take-back and recycling initiatives reported on in the Case Studies have been sustained by cost savings. Some companies in the electronics industry, notably, have discovered that they can make money by recovering and reusing valuable components and recycling high-priced metals. Even with plastic materials, some automotive companies have found significant cost savings in recycling.
- **Environmental Stewardship** - All of the companies discussed have adopted environmental stewardship as a corporate ethic. They see EPR initiatives as a proactive way of demonstrating their commitment to this corporate ethic.
- **Product Innovation** - Many of the companies studied found that extending responsibility to additional stages of the life cycle resulted in product innovations that either saved money through more efficient manufacturing or allowed cost savings in materials use. For instance, the focus on end-of-life management for refrigerators and computers led the producers to reduce the number of parts and the number of materials used in the products, resulting in cost savings in manufacturing. The focus on design-for-disassembly to facilitate recycling also led to faster and cheaper assembly during manufacturing.
- **Customer Satisfaction and Loyalty** - Consumer products producers, particularly some computer manufacturers, see product upgrades and take-back and recycling programs as a means to increase customer satisfaction and loyalty. If a computer is readily upgradeable, it is more likely that the customer will remain loyal to the brand over the long term. And if the nagging problem of what to do with an obsolete computer is solved by the producer, the customer is more likely to consider purchasing a new computer from the same company. Similarly, materials suppliers can increase customer satisfaction and loyalty by helping solve their customers' materials recycling headaches.
- **"Green Marketing"** - All of the companies discussed in the case studies produce products that are sold to consumers who are increasingly concerned about the environmental performance of the products they purchase. One reason that most of the case studies involve recycling is that this is the most visible and frequently reported on environmental attribute of products today. Recycling has become an ingrained value in our society, and most of the companies studied have ambitious corporate goals to increase recycling.
- **Take-Back Mandates in the U.S. or Abroad -** Many U.S. companies discussed in the case studies in this report are responding, at least partly, to mandates in the U.S. or abroad. This calls into question exactly what "voluntary" means in the context of these initiatives. In the rechargeable battery case, for instance, two states had already required take back and recycling of nickel-cadmium batteries, so the nationwide program created by the battery industry can be seen as one that sought to avoid inconsistent regulations from state to state. In both the electronics and automotive cases, the German take-back proposals have encouraged some U.S. manufacturers, who also do business in Europe, to demonstrate progress in end-of-life management with the intent to avoid the threat of such mandates in the U.S.

- **Existing Facility-Based Environmental Regulations and Environmental Liabilities** - As existing facility-based environmental regulations restrict waste disposal options, and environmental liabilities make use and disposal of hazardous substances a potential financial disaster, companies have discovered that EPR may be the most effective and economically efficient means to comply with regulations and avoid liabilities. Some of the DfE and recycling programs reported on in the case studies were motivated, in part, by potential bans on disposal of substances contained in the products. Automotive companies, for instance, have instituted restrictions on hazardous substances in materials and components supplied to them by their suppliers. Through the application of EPR, many companies have redesigned products to eliminate hazardous substances, instead of spending money to treat and dispose of hazardous waste.

ENDNOTES

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CHAPTER 3

EXTENDED PRODUCT RESPONSIBILITY IN THE ELECTRONICS INDUSTRY

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3.1 INTRODUCTION

Electronics firms are subject to a proliferation of international environmental policies and standards that go beyond traditional concerns about manufacturing process wastes and releases to impact corporate management practices, product design and marketability, and post-consumer product disposal. Their suppliers and customers are increasingly sensitive to environmental issues such as energy efficiency, material use (e.g., recycled content, ozone-depleting substances concerns), and environmentally-sound product disposal and recycling, motivating electronic firms to manufacture and supply appropriate products and services.

The market for electronic products is highly competitive. As demonstrated in these case studies, extended product responsibility (EPR) presents opportunities for companies to lower the cost of doing business for themselves as well as their customers, and increase customer satisfaction by offering products and services that meet the environmental performance needs of their customers. Indeed, global competitiveness today hinges on delivering products that meet customers' price and performance preferences, while improving the life-cycle environmental performance of products.

This chapter highlights the voluntary EPR activities of three electronics companies, Compaq Computer Corporation, Hewlett-Packard Company, and Northern Telecom. Each of the companies has developed a systematic approach to the life-cycle management of its products across the corporation, building on efforts in the 1980s to control and reduce manufacturing emissions and waste. These cases illustrate the breadth and quality of EPR programs in the industry, including design for environment, product take back, and new customer-supplier partnerships, as well as the drivers of change. In many respects, these programs are in their infancy, but represent the leading edge of product life-cycle management. Given technological innovation, competitive trends in the industry, and international policy developments, we can only expect continued progress.

3.2 DESIGN FOR ENVIRONMENT AT COMPAQ COMPUTER CORPORATION

"We believe that striving for exemplary environmental performance is essential to sustaining market leadership."

1994 Summary Annual Report

Compaq Computer Corporation believes that environmental responsibility begins with product design and manufacturing, and continues to the end of the product's useful life. This philosophy evolved over time, beginning with a traditional focus on manufacturing concerns and the prevention of wastes and emissions in the 1980s. With a goal to eliminate the use of chlorofluorocarbons (CFCs), Compaq began to take a step back in the product life cycle to alter the process design. This was not enough. In 1992, Compaq began to push further back in the product life cycle to influence product design.[1]

Compaq Computer Corporation, headquartered in Houston, Texas, is the world's largest supplier of desktop, servers, and portable personal computers to commercial and residential markets. Compaq sells its products in more than 100 countries, mostly through its network of dealers, distributors, and value-added resellers. Founded in 1982, Compaq now operates manufacturing facilities in five countries and employs 17,000 people world-wide. In 1995, sales reached almost $15 billion.

World-wide competitive pressures have led Compaq to redefine the boundary of its product life cycle. In earlier years, Compaq considered its job done when the product left manufacturing and was sold in the marketplace. The introduction of a 3-year warranty extended Compaq ownership concerns through service and support. With the advent of "take-back" legislation in Europe, Compaq's view of the product life cycle was stretched all the way to the end of its product's life.

This paradigm shift created a new mandate for design. The ability to cost-effectively service and repair the product, as well as recycle the product at end of life, became an integral part of the competitiveness equation.

Product life-cycle management at Compaq is market driven. For this reason, Compaq is not developing complex life-cycle analysis tools to identify environmental impact. Rather, customer needs, expectations and regulatory trends are translated into product, process or service features. The personal computer industry is also a high-volume, low-margin business. Therefore, Compaq must pay particular attention to costs.

3.2.1 Compaq's Design for Environment (DfE) Program at a Glance

At Compaq, product design occurs within an established product development process, beginning with product definition and moving through product manufacture. Early on, the environmental organization within Conpaq realized that in order to influence product design, it had to work within the system. As a result, an engineer from Compaq's engineering design organization was brought onto the environmental staff to spearhead the development of environmental design guidelines that fit within Compaq's design culture. Rather than dictate a set of design guidelines, the environmental staffs' strategy was to create a forum for the discussion of environment in design, and then leverage the expertise of cross-functional design teams to develop design guidelines.

Compaq's initial efforts to change design practices focused on plastics. The polymer guideline, which was released in 1993, provides recommendations on selection of plastics, including preferred polymers, and other design considerations to improve recyclability: for example, consolidation of material types in a product and the use of flame retardants and plastics identification markings. The polymer guideline was later published as a corporate specification.

In 1994, Compaq completed a comprehensive environmental design guideline. Rather than focus its efforts on a single product, Compaq's approach has been to implement the program across all product lines. As discussed below, these design efforts have resulted in the introduction of new product lines with environmental features.

The design guide promotes the adoption of a life-cycle perspective in the design of products, and specifically addresses the following issues:

- Material Selection, focusing on Recyclability.
- Design for Disassembly.
- Packaging Materials.
- Energy Conservation.
- Design for Reuse and Upgradeability.

Table 3-1 highlights some design parameters within each category.

Cross-functional design teams, which include representatives from engineering, packaging, purchasing, finance and marketing, apply the design guidelines within their jurisdiction. For example, the mechanical engineering team applies the polymer standard in establishing hardware product specifications; the printed circuit board designers consider upgradeability issues; packaging engineers incorporate packaging standards; and the service organization provides feedback on design features impacting serviceability (e.g., use of thumb screws, the need for special tools to disassemble).

Compaq finds synergy between DfE and other priority design objectives, namely design for manufacturability and design for serviceability. For example, fewer parts simplifies manufacturing, while facilitating recycling. Similarly, easy disassembly facilitates the servicing, upgrading, and recycling of equipment as well.

Table 3-1: Sample Design Guidelines

- **Packaging**
  - Minimum 35% recycled content
  - No heavy metals in packaging inks
  - 100% Kraft paperboard, no bleach
  - Use of recyclable materials only

- **Plastics**
  - Use only recyclable thermoplastics
  - Consolidate plastic types
  - Use ISO markings to identify resin type and exact blend
  - No paint finishes
  - Labels: molded in or use same resin type as housing

- **Disassembly and Recycling**
  - Use of standard screw heads
  - Design modular components
  - Minimize number of parts

- **Energy Conservation**
  - Comply with Energy Star standards

- **Design for Reuse**
  - User upgradeability
  - Use of industry standard architecture

3.2.2 EPR Results

Examples of Compaq's efforts to reduce environmental impact throughout the life cycle of its products include:

- Eliminating ozone-depleting substances from manufacturing processes. Compaq accomplished this in 1993, years ahead of the schedule established by the Montreal Protocol.
- Minimizing waste generation and energy use in manufacturing. To help further waste reduction and energy conservation progress, in 1993 Compaq established a world-wide environmental performance measure that quantifies pounds of by-product and energy consumed per PC produced. From 1993 to 1994, the manufacturing by-products were reduced 34 percent per unit worldwide.[2] At their manufacturing site in Houston, Compaq reduced electricity use per PC manufactured by 34 percent in 1994 compared to 1993.[3] Regarding wastes, Compaq's ultimate goal is the total elimination of waste in all manufacturing processes.[4]

- Reducing energy consumption of its products. According to EPA projections, with the power management features activated on the desktops and monitors Compaq shipped in 1995 alone, the estimated worldwide energy savings could be as much as $60 million dollars. It could also reduce CO_2 pollution equal to the emissions from 150,000 automobiles.
- Designing products for upgrades and recycling. Compaq's efforts increase the likelihood of resource conservation through product life extension and recycling, as discussed further below.

Through these initiatives, Compaq demonstrates that products can have reduced environmental impact, while achieving business objectives, such as reduced costs for Compaq and its customers and increased competitiveness.

Easy Upgradeability

One of the most promising "reuse and recycling" opportunities can be found in upgradeable products. Product upgrade features help avoid early obsolescence and increase the product life by facilitating the replacement of electronic components, while avoiding the unnecessary disposal of mechanical parts, such as the plastic housing, power supply and metal chassis, which do not impact product functionality.

For example, a customer who purchased a 486/33 MHZ computer with 4 megabytes of RAM will have trouble running Windows 95. Rather than discarding the old computer and buying a new Pentium-based computer, a user can attain similar results by upgrading the microprocessor to a Pentium and adding additional RAM. The added bonus — the upgrade is a fraction of the cost of a new computer.

While any PC can be upgraded if you have the technical knowledge and are willing to replace the motherboard or manually de-solder the microprocessor chip,[5] Compaq's designs are truly "upgradeable" by the average user without the use of specialized tools and the risk of damaging the computer. This is accomplished through the use of alternative technologies for mounting components and easily accessible subassemblies. In Compaq's recent ProLinea® and Deskpro® models, a user can easily upgrade the entire motherboard, the microprocessor, or the memory and easily access the hard drive and expansion slots to replace or add new features.

One technology that enables easy upgrades is the ZIF (zero insertion force) socket that holds the microprocessor in place on the motherboard. This socket replaces the traditional solder mounting, which is considered a semi-permanent connection technology. The ZIF socket uses a tension bar to hold the microprocessor and force a connection. This technology allows the user to easily remove and replace the old microprocessor and install updated or faster technology, simply by unlatching and relatching the bar.

From an environmental vantage point, upgradeable products conserve resources. For the most part, however, this is not critical to the purchasing decisions of customers, who are concerned predominantly about costs and product features. For Compaq and its customers, the upgradeable PC is important from another angle. It lowers the lifetime cost of computer ownership, a growing concern to customers as technological obsolescence occurs at an ever increasing rate. In this regard, Compaq's marketing literature extols the virtues of its upgradeable product:

> "Needs change, goals change, and people change. The good news is, a Deskpro computer can change every bit as quickly. It opens without any special tools. The system board slides out, making it easy to upgrade the processor or add extra RAM. The PCI expansion slots are easily accessed. And the drive cage swings out to make hard drive upgrades painless.....With the task of upgrading a PC reduced to minutes, you can allocate your time to more lucrative pursuits."[6]

Upgradeable products also lower the costs of servicing products, for those customers who do not want to do it themselves. While upgradeability has several advantages, both environmental and economic, it does have its limitations. The biggest limitation is technological change. If the basic architecture of the computer or its components changes, for example, upgrades might not be an option. So, for a computer coming on the market today with upgrade features, it is unclear how long the current technology will be compatible with future generations.

Design for Recycling

The design of products to facilitate recycling at the end of life is a major focus of Compaq's environmental design efforts. These efforts focus largely on plastics, currently the most difficult wastestream to recycle at the end of a PC's life, including:

- Removal of flame retardants that contain polybrominated biphenyls, dioxins and cadmium from plastics, many of which are restricted substances in Europe.
- Reduction in the number of plastic types to favor two polymer compositions, ABS and polycarbonate, which now make up 90 percent of all plastic used at Compaq.
- Use of detailed markings on plastic to identify resin type, manufacturer and exact blend, which facilitates the reuse of these plastics in high grade applications and prevents future downcycling.

In addition, due to efforts to design upgradeable products, Compaq computers are easier to disassemble. Components such as microprocessors, hard drives and memory are also pulled out easily and undamaged, which facilitates resale and reuse opportunities.

3.2.3 Compaq's Experience with Product and Packaging Recovery

Recognizing its responsibility to help manage the end of life of its products, Compaq has initiated several programs over the past four years to recover and recycle its products, product components, and packaging. Although well-intentioned, these programs have been limited by low customer participation rates, illustrating that EPR sometimes needs more than a willing producer to make a difference.

Battery Take Back

In 1992, Compaq initiated the first U.S.-wide take-back program for portable rechargeable battery packs, in response to a patchwork of state battery laws. The program is user friendly and provided at no cost to customers. The customer calls a toll-free number and provides the product name and serial number. A pre-addressed, postage-paid mailer is sent to the customer. Using the mailer, the customer sends the battery directly to a reclamation facility approved by Compaq. Compaq incurs all program costs (about $5 per pound of batteries processed) including the 800 number, mailers, postage, and processing fees.

The market response to Compaq's battery recycling program has been limited, according to Walt Rosenberg, Corporate Environmental Manager, although there was a 17 percent increase in participation between 1993 and 1994.[7] About 1,000 to 2,000 batteries are recycled each month, representing less than ten percent of Compaq products on the market. The program is advertised via inserts in new Compaq portable products and periodically in product advertisements. Program information is available from the dedicated Battery Return Program hotline, information software supplied with new Compaq products, the toll-free Compaq Customer Support Center, and authorized Compaq dealers.

Equipment Recycling

Compaq offers product recycling in selected markets. In Switzerland, Compaq participates in an industry-established system, while in Germany, where the take-back concept first gained notoriety, Compaq offers a recycling service through independent contractors. Customers pay approximately $25 to $30 for this recovery and recycling service, which is consistent with the current economics of electronics recycling in Europe.

In its four years of experience with product take back, Compaq reports insignificant customer response. In Germany and Switzerland combined, approximately five systems are recovered each month. Customers are inclined to sell or give away their used equipment, or store it indefinitely.

In the U.S., Compaq is receiving more and more inquiries about environmental issues, including requests for product recovery, particularly from major accounts concerned about long-term liability. Upon request, Compaq has assisted these customers in equipment disposition. Compaq also recycles excess production materials and operates a factory store, where product returns and excess equipment are offered for resale.

Logistical constraints make large scale equipment recovery from end-use customers particularly unattractive and costly for Compaq (and ultimately the customer). The major costs associated with equipment recovery and recycling for Compaq, as well as other electronics manufacturers, is in deinstallation and reverse logistics (that is, moving products from the end user site back to the manufacturer). The majority of Compaq equipment is distributed, installed, serviced, deinstalled, and even leased through third parties. With the exception of product under warranty, Compaq typically does not receive used or leased equipment back from customers.

Compaq's experience with battery take back and product recovery in Europe indicates a low value placed on such services by customers. The top priorities of customers remain cost, quality, and serviceability. Given the cost of reverse logistics, it will generally be more cost-effective for most Compaq customers to utilize existing channels for recycling their used equipment (e.g., third party electronic recyclers and used equipment brokers) rather than turning to Compaq for this service.

Packaging Pilot

In 1994 Compaq initiated a pilot program for the recovery of foam inserts used to package network servers. Customers were provided with a postage-paid mailer to return the foam insert. Upon return, foam inserts were inspected and designated for reuse or recycling. Again, the results were disappointing. Of the 5,000 units targeted, only two foam inserts were returned by customers, indicating that recycling foam inserts is not a priority of customers or they have another outlet for recycling.

3.2.4 Supplier Management

Compaq purchases some components and subassemblies for integration into its final products. To control the quality of inputs, and thus the quality of Compaq products, the company instituted a "world-class" supplier process. Compaq evaluates vendors along seven dimensions including quality, capability, responsiveness, and price. Environmental issues are included in the evaluation and vendor approval process.

Compaq requires suppliers to certify that they do not use CFCs or HCFCs in their products or processes and that they have not been excluded from federal government procurement for environmental reasons. This certification helps ensure that Compaq's products will not be shut out of markets due to vendor practices. Compaq also conducts site surveys as part of the supplier management program. Prospective suppliers are evaluated and graded (on a scale of zero to four) on aspects of their operations, such as order processing, quality inspection process, calibration, and environmental programs. To be awarded a contract with Compaq, a vendor must receive a minimum score, representing the sum of all activities evaluated.

The evaluation of environmental programs specifically examines and rates a vendor's environmental, health, and safety compliance record; environmental policy and commitment to address environmental issues; waste minimization program; and self-evaluation program (i.e., audit program). As an example, if there was "no evidence" of a waste minimization program, a supplier receives zero points. In contrast, a company that has developed waste minimization objectives and metrics and has integrated these objectives into its business plans receives the highest score, or four points.

The process is used to inform suppliers of Compaq's expectations and to help suppliers improve their programs if needed. Suppliers with low scores are given the opportunity to develop new programs and raise their scores. As a result of this program, for example, several companies stopped using CFCs in order to meet Compaq's requirements. Although many of its suppliers meet Compaq's minimum expectations, they strive to continually improve their scores.

3.3 PRODUCT STEWARDSHIP AT HEWLETT-PACKARD COMPANY

To provide products and services that are environmentally responsible throughout their life cycles and to conduct business operations worldwide in an environmentally responsible manner.

Corporate Environmental Policy, 1992

Hewlett-Packard Company (HP) designs, manufactures and services communications, measurement, and computation equipment. Computer products and services, from personal computers to workstations, printers and network systems, account for 80 percent of HP's business. Other major product lines include electronics test equipment, medical diagnostic systems, laboratory instrumentation, and electronic components. In 1995, HP posted net revenues of over $30 billion and employed over 100,000 people world-wide. The company operates 60 manufacturing sites throughout North and South America, Europe, Australia and Asia. Its products are in use in over 120 countries.

Hewlett-Packard Company's (HP) environmental philosophy took a significant stride in 1992 with the launch of its product stewardship program. The company made a commitment to move beyond the factory and an emphasis on the manufacturing process to embrace a new life-cycle philosophy. The life-cycle approach broadened HP's concerns to encompass product design, packaging, distribution, use and disposal, in addition to traditional manufacturing issues. Most importantly, the life-cycle approach allows HP's business units to identify and address emerging global product legislation and market expectations. HP's product stewardship program was triggered by a desire to stay ahead of legislative developments and voluntary programs such as German take back and U.S. Energy Star requirements, and to respond to an increase in the number of customers seeking more environmentally-sound products.[8]

At the root of its life-cycle approach is design — this is, design to minimize adverse health, safety, and environmental impacts from the manufacture, use, and disposal of its products. This focus on product design is critical to achieving environmental improvement, given the rate of new product introductions. More than half of HP's 1995 orders were for products introduced in the previous two years.[9] To address this issue, HP has developed Design-for-Environment guidelines that encourage the development of new products that incorporate energy-saving features and recyclable materials, and that reduce waste generation in manufacturing processes.

Hewlett-Packard's product stewardship efforts extend beyond product design. To influence the inputs to its products and processes, HP developed its supplier "E" process, which adds environmental issues to vendor management along side traditional concerns such as quality, delivery, and cost. At the end of product life, Hewlett-Packard engages in selected collection of products from customers for processing at recycling centers in the U.S. and Europe.

3.3.1 Product Stewardship: From Concept to Implementation

Hewlett-Packard's product stewardship program was designed to accommodate the needs of a highly decentralized company, where business units operate in an environment characterized by intense competition and rapid technological change. Furthermore, it is a global marketplace. Hewlett-Packard operates 60 manufacturing sites world-wide, deals with more than 10,000 suppliers, and sells products in 120 countries.

To address these needs, HP's corporate environmental management function was tasked with the following mission:

> *"In partnership with HP's geographic organizations and other corporate functions, provide a strong facilitation platform to the HP businesses and be proactive in elevating awareness and leveraging product stewardship solutions for improved business results."*

As a result, Hewlett-Packard developed a global product stewardship network and management process that provides business units with support, tools and information, as well as autonomy, to develop responses that meet the demands of their product lines and customers.

Each of HP's product lines has a product steward who champions the program and coordinates efforts to identify, evaluate and respond to any market forces that could impact that product line. The product stewards create cross-functional teams, as needed, to deliberate issues and weigh all aspects of design — from cost and performance to environmental impact. Ultimately, the success of Hewlett-Packard's product stewardship program rests with product line management, since it is up to them, with the assistance of the product stewards, to act upon relevant information.

Hewlett-Packard established an on-line information system to help business managers and product stewards world-wide stay abreast of environmental issues and informed decision making. The database contains current and proposed legislative requirements, market developments, and Hewlett-Packard's Design-for-Environment (DfE) guidelines. Product stewards can access documents on subjects such as batteries, ecolabels, packaging, energy, and product take back. The information is organized by geographic regions, as well as topics, and is accessible using a keyword search feature.

A global product stewardship council, comprised of senior level business managers from each of HP's major businesses, oversees company-wide implementation of the program. The council initiates projects to address company-wide issues and program needs. For example, teams have been created to address European product take back, battery legislation, lead in electronics assemblies, and plastics procurement and recycling. Resulting recommendations are communicated to the product stewardship network for appropriate follow-up action by the product line.

In mid-1995, four years after the initiation of its product stewardship program, Hewlett-Packard put one of its last key processes, the business self-assessment, in place. The self-assessment procedure is designed to promote the further integration of product stewardship into the mainstream of HP's business by ensuring the involvement of senior business managers. Essentially a self-audit using Quality Management System (QMS)-type questions, the procedure helps business managers verify that their businesses and products are positioned appropriately to address emerging market forces, such as customer expectations, legislative requirements, voluntary standards, and competitor initiatives.

The self-assessment also measures internal deployment of product stewardship programs, including HP DfE guidelines, the supplier "E" process (see below), and appropriate awareness-building and communication vehicles. Feedback from initial application of the self-assessment procedure has also identified opportunities to improve support services for product stewards: for example, providing more comprehensive summaries of legislation and eco-labels on the company-wide on-line information system.[10]

Supplier "E" Process

> *"Although HP does not intend to dictate how suppliers should comply with or meet environmental requirements, HP will favor, whenever possible, suppliers who demonstrate the best Technology, Quality, Responsiveness, Delivery, Cost and Environmental (TQRDC-E) performance."*[11]

In support of HP's product stewardship program, HP's procurement organization established environmental criteria to inform suppliers about HP's environmental performance expectations. As a result, HP's supplier performance metrics, TQRDC-E, now include "E" for environment along with technology, quality, responsiveness, delivery, and cost criteria. Supplier "E" criteria have been developed on two levels: global and commodity specific.

HP suppliers on a world-wide basis are expected to meet three global "E" criteria:

1. Establish an environmental policy, endorsed by top management, that commits the company to continuous environmental improvement.
2. Develop an implementation plan with well-defined metrics that supports the environmental policy.
3. Eliminate ozone-depleting substances from operations and products.

HP further suggests that environmental improvement policies cover manufacturing processes, information and labeling, recycling and reuse, power consumption reduction, packaging, and disposal in the brochure that it distributes to suppliers.[12]

Suppliers are rated on a scale of zero to four for each "E" criteria, and a total score is calculated based on the sum of the weighted score for each criteria. Similar scores are derived for each TQRDC-E metric. A supplier's overall score is the average score for the six metrics. HP uses a supplier's overall rating to compare it to other suppliers of the same commodity when making sourcing decisions. Equally important, the rating system provides a tool for communicating environmental expectations and performance with suppliers. For example, HP credits the Ozone Depleting Substances (ODS) supplier "E" criteria with bringing "tremendous supplier compliance."[13]

In addition to the global "E" criteria, commodity-specific "E" criteria have been established to promote the development of environmentally responsible materials and processes, including plastic resins, CRT monitors, power sources, and contract manufacturing. Implementation of the commodity-specific "E" criteria for plastic resin (see Table 3-2), in conjunction with resin recyclers and suppliers, resulted in the launch in 1995 of the first HP DeskJet printer manufactured with recycled plastics.

Table 3.2: HP's Plastic Resin Commodity Specific "E" Criteria

E1: Recycling

1. Program to take back post-consumer plastics from HP for formulation of recycled resin.
2. Offers minimum 25 percent recycled-content plastic resin.
3. Program to make available HP requested recycled resin, if not commercially available.
4. Offers recycled plastic resin at parity or lower prices compared to comparable virgin grades.

E2: Environmental Awareness

1. Aware of and in compliance with country-specific requirements (e.g., PBB, PBDEs).
2. Informs HP about potential bans on plastic additives and offers alternative solutions.
3. New product developments reflect existing and emerging worldwide environmental, recycling, health, and safety requirements.
4. Participates in industry organizations and is abreast of worldwide environmental and legislative trends affecting manufacturing and product use.

E3: Waste Reduction

1. Program to help HP reduce amount of material used in applications.
2. Processes to reduce and responsibly dispose of production wastes.
3. Minimize, reuse, or recycle packaging materials.
4. Programs/plans to offer environmentally sound disposal solutions for non-recyclable materials (e.g., mixed or contaminated plastics).

Source: Choong, Hsia. 1996. "Procurement of Environmentally Responsible Material," IEEE International Symposium on Electronics and the Environment. May.

Product Stewardship at the Business Level

The Computer Products Organization (CPO) first tested product stewardship practices within HP beginning in 1992, and developed the prototypes of several tools now in use company-wide (e.g., DfE guidelines, on-line information system, supplier performance criteria). As the producer of HP's widely-recognized and high-volume LaserJet and InkJet printers and personal computers, CPO was a good place to start. CPO was subject to a proliferation of emerging "green" market forces: customers were increasingly asking about environmental features and the environmental impact of HP products, including energy efficiency, packaging, recyclability, and the use of ozone-depleting substances; ecolabels and voluntary standards were driving competitors to introduce new products; and European take-back requirements were pushing product stewardship.[14] Since CPO manufactured high-volume products, focusing on these products presented HP with its greatest opportunity to reduce environmental impact.

CPO developed a set of metrics to help drive product stewardship improvements and to provide management with a mechanism to review and measure progress. The metrics shown in Table 3-3 were chosen based on customer inquiries, government initiatives, proposed ecolabel criteria, and end-of-life handling considerations. For products, consumables and packaging, CPO chose to focus on energy efficiency and reducing its contribution to the wastestream.

Table 3-3: CPO Performance Metrics

I. Product, Consumables, and Packaging

Material Conservation and Waste Reduction
- Mass (kg)
- Projected % remanufacture or reuse
- Projected % recycled

Energy Efficiency
- Normal operating mode (watts)
- "Sleep" mode (watts)
- Off mode (watts)

Design for Environment
- Variety/number of materials
- Plastics marked (yes/no)
- Disassembly time (minutes)
- Recycled material content (%)
- Number of materials requiring special handling

II. Manufacturing Process

SARA 313 emissions (kg/yr)
Hazardous waste generated (kg/yr)
Hazardous waste reused/recycled (%)
Solid waste generated (kg/yr)
Solid waste reused/recycled

Source: Korpalski, T. 1994. IEEE Proceedings. May.

Product lines select specific objectives for improvement and set goals. Results are measured as a percentage improvement above the baseline year. The next section discusses results for one product, the Vectra personal computer.

3.3.2 Product Stewardship Results

Improving Product Environmental Performance Through Design

Table 3-4 provides some environmental improvement results for HP's Vectra series of personal computers, accomplished over the past five years. Most of the Vectra PCs meet U.S. Energy Star requirements and are easier to disassemble and recycle than previous models due to the use of fewer materials, parts, and screws. Indeed, it takes a recycler only four minutes to break down the computer into its component parts. In addition, the product mass was reduced by 46 percent, while the manuals were cut by over 60 percent.

Table 3-4: Environmental Improvements for HP Vectra Personal Computers

Metric	Improvement
Number of parts	1,650 to 350
Weight	13 kg to 7 kg
Number of screws (to module level)	4
Time to disassemble (to module level)	4 minutes
Number of materials (housing and chassis)	2 (pure plastic and steel)
Energy efficiency	All 486s and most Pentiums meet Energy Star requirements
Batteries	No heavy metals No batteries in some models
Flame retardants (housing and chassis)	No brominated flame retardants (PBB/PBDE)
Packaging	75% recycled corrugated EPS Foam No heavy metals in inks
Manuals	400 pages to 150 pages 50% recycled content Recycling compatible binding No heavy metals in inks

Source: Korpalski, T. 1996. "The Role of the 'Product Steward" in Advancing Design for Environment in Hewlett-Packard's Computer Products Organization, IEEE International Symposium on Electronics and the Environment. May.

Other environmental attributes in the Vectra model, as well as most current HP personal computer products, include:

- All but the smallest plastic parts carry markings that identify the type of plastic, making the plastic easier to recycle. HP uses the standards developed by the International Standards Organization (ISO).

- The elimination of poly-brominated diphenyl ethers (PBDEs) as a flame retardant in the plastic housings and keyboards, which may emit dioxins when burned.
- Batteries do not contain heavy metals.[15]

A tribute to its environmental performance, HP's Vectra VL series carries the comprehensive German Blue Angel environmental label for PCs. The German Blue Angel is granted only to PCs that meet or exceed 65 requirements in a broad range of environmental and safety categories. Product recycling is an important aspect in PC Blue Angel certification. Numerous criteria focus on some aspect of recycling, from material selection and identification markings to the use of screws to facilitate recycling. Furthermore, Blue Angel certification requires the manufacturer to provide a written commitment ensuring the recovery and recycling of the product at end of life at no cost to the customer. Other PC Blue Angel criteria cover, for example, expandability/upgradeability, batteries, and energy consumption.

Energy Consumption

HP offers more than 100 product models that meet or exceed U.S. EPA Energy Star criteria, including 100 percent of its printers, plotters, facsimiles, 486-based PCs, and PC display monitors. For HP's customers, this translates into reduced energy use and costs. For the environment, this means a reduction in fuel use and power plant emissions.

Given the proliferation of Energy Star products on the market, the logo is not a market differentiator for HP, although the absence of the logo is seen as a competitive disadvantage. For example, President Clinton signed an Executive Order in 1993 requiring federal agencies to purchase only computers and printers that meet Energy Star requirements. According to Cliff Bast, HP's corporate product stewardship manager, the structure of the Energy Star program is a good one: "it was not designed to pull in elite products only, but to get maximum amount of participation, and therefore, maximum environmental benefit." This is in contrast to the German Blue Angel, which establishes multiple stringent standards in an "all or nothing," resource-intensive certification process.

A New "Packaging" Concept Reduces Waste

One innovative solution developed in HP's workstation division requires 30 percent less packaging because protective packaging is built into the product itself, instead of being wrapped around it. The new HP Packaging Assembly Concept (PAC) replaces the metal chassis with expanded polypropylene (EPP) foam. The foam chassis cushions sensitive electronic parts during shipping, while reducing the number of mechanical parts needed to hold parts in position. The foam chassis has an added benefit of reducing product development time, since prototypes require less preparation and assembly time with the easy to mold foam.

Hewlett-Packard's chemical analysis business adopted the innovative E-PAC technology in its new 1100 Series HPLC systems. This new packaging design resulted in major costs savings in assembly and disassembly, since fewer parts and no assembly tools are needed. For example, the new product design resulted in:

- 70 percent reduction in mechanical housing parts.
- 95 percent reduction in screw joints.
- 70 percent reduction in assembly time.
- 90 percent reduction in product disassembly time compared to previous models.

EPP foam can also be 100 percent recycled into source material polypropylene.[16]

Asset Management and Recycling

Managing the end of life of electronic equipment provides multiple business opportunities for Hewlet-Packard, from improved customer service and sourcing of spare parts to new revenue streams in some cases. The company's two equipment recovery operations in the U.S. are strategically located within the HP organization to reflect their mission. The Hardware Recycling Organization (HRO) is part of the Support Materials Organization (SMO), which is responsible for worldwide distribution and repair service material. In contrast, the home of the asset management group servicing the Technical Computer Business Unit, also known as Alternative Inventory Solution, is within the marketing group.

The primary mission of the HRO, located in California, is to process useful service parts through the disassembly and refurbishment of HP and non-HP excess equipment and parts. HRO also serves as one of HP's recycling hubs. Equipment and parts that are not suitable for service are routed to environmentally-responsible, non-competitive recovery channels.

Salvaging parts from used equipment allows HP to improve its service levels; in particular, it increases parts availability while lowering costs. Indeed, the origins of the HRO operation lie here. In 1987, HP found it difficult and expensive to obtain new service parts for some printers. In its search for solutions, the service organization found tear down of used equipment and subsequent refurbishment of parts to be a cheaper and more reliable source of service parts. HRO could fill an order for spare parts in two weeks time, in comparison to over six months for new parts. HRO now stocks the service supply pipeline, resulting in an immediate turn around for service parts. Stocking service parts using the HRO organization also frees up HP's manufacturing capacity, allowing production units to concentrate on manufacturing new products. In addition, for some older technologies that are no longer in production, recovery of service parts from used equipment is the only option, and therefore, is vital to keeping equipment in service.

The HRO facility processes 9,000 tons of equipment annually with a total "recycling" rate of over 99 percent (including some incineration with energy recovery). Less than one percent of product goes to landfill. Sixty percent of the equipment processed at the facility comes from HP divisions (e.g., internal equipment, excess inventory), while deinstallation from customer sites and HP's service organization account for 25 percent and 15 percent, respectively.

At the facility, incoming product lots are weighed and unpacked. Product numbers are entered into a computer system and any service parts identified. The products are then routed to either disassembly for removal of service parts or reclamation. Equipment that is not utilized for service is diverted to non-competitive recovery channels, including component resale and material recycling. Of the equipment processed, the disposition of products breaks down as follows:

- 70 percent reclamation, which includes pulling integrated circuits and material recycling of precious metals, plastics, nonferrous metals, and CRT glass.
- 18 percent resale of components and parts, such as disc drives, fans, and motors.
- 12 percent recovery of parts for use in HP's service organization. Service parts designated for recovery include, for example: electronic assemblies, boards, drives, and monitors.

In the past, the HRO program was passive; the program waited for equipment to come to it. This is changing into a more active program that deliberately pulls products from markets into the HP recycling system in order to recover valuable service parts. For example, in late 1994, HP's marketing department initiated a tradeup program for LaserJets with a dual goal. An obvious goal was to increase the sale of new LaserJets; an additional driver was to increase the supply of spare parts to the service organization and to lower service costs. HP will also buy back equipment with needed service parts, although the company offers no formal product take-back program.

The biggest problem materials for the recycling organization are plastics and cathode ray tubes. HP is beginning to find solutions for plastics, now that the company is looking at plastics recycling from a financial perspective. One year ago, HP was sorting all plastics, despite a lack of markets for the material. The company then shifted its focus to recover only those plastics that were in market demand, and in particular, plastics that were in demand by HP. HRO started with ABS, which represents 12 percent of the wastestream. HP worked closely with a resin supplier to develop a recycling solution and infrastructure, which allows closed-loop recycling of ABS. (See discussion in *Plastics Recycling Project* section.) Using the ABS model, HP plans on tackling other plastics, in particular, polystyrene and polycarbonate, which together with ABS, account for 80 percent of the recoverable plastics stream.

For HP's HRO organization, the bottom line is that the recovery of service parts is very profitable, while the unit strives to break even on its recycling activities. Historically, the largest revenue generators have been chip recovery, precious metals and resale of disk drives, fans, and motors. However, these markets are volatile (as demonstrated by the plummet in the DRAM market in mid-1996), impacting the economics of electronics recycling. In addition, CRTs and plastics recycle are financial drains, although ABS recycling is reaching a break even to slightly positive cash flow.

The HP Technical Computer Business Unit (TCBU), which manufactures workstations and other high-end computer systems, operates its own recycling organization from its headquarters in Massachusetts. Like the HRO organization, this recycling operation, also known as Alternative Inventory Solutions (AIS), has strategic importance to the company. The program:

- Provides alternative sources of equipment and service parts to HP.
- Ensures that equipment does not enter the gray market.

- Recovers maximum value from equipment, without damaging new product sales.
- Ensures proper disposal of equipment.

A workstation, or Unix server, has greater value when it enters the marketplace and when it leaves the marketplace, compared to a PC or printer. For this reason, HP is able to recoup "significant" savings and revenues (after expenses) from this operation. Over 70 percent of the equipment and subassemblies processed by AIS is returned to HP for reuse or resale, while only 30 percent goes to third parties for recycling. Reuse and resale opportunities include, for example:

- Product remanufacture, where systems are upgraded to incorporate design changes or features introduced since the product's inception (e.g., CPU board upgrade). These systems are tested to ensure that they meet HP quality standards.
- Recovery and refurbishment of service parts for HP internal use (e.g., boards, disc drives, cables).
- Sale of commodity items (e.g., disc drives, monitors, integrated circuits) to secondary markets.

HP is trying to increase its sale of remanufactured equipment. Such equipment may fill an existing customer's expansion needs or target new markets. New markets are targeted for strategic purposes. For example, HP seeks entry into new geographic and vertical markets, where potential customers may not be able to afford the latest technology (e.g., developing countries, educational institutions). Used product sales create current revenue streams, while increasing HP's presence in the market and competitive edge for future sales of new products. Used equipment also is offered for sale to HP partners, such as software developers, to create goodwill and strengthen alliances. Whether reselling equipment or parts, however, HP is careful not to compete with new product sales or HP's service organization.

Plastics Recycling Project

Finding solutions for the plastics wastestream from scrapped products is a priority for HP, with preference given to recycling. At the same time, HP product groups are looking towards meeting the expectations of an increasingly environmentally-sensitive customer base. Merging these two objectives, HP is working with its suppliers, its recycling organization, and its printer division to qualify recycled content plastic in HP product, thereby creating a market for the output generated by the recycling organization and improving the environmental profile of its products.

In July 1995, HP introduced its first recycled-content product to the U.S. market, the DeskJet 850C InkJet printer. The printer's outer cover contains up to 25 percent recycled-content ABS, a combination of post-consumer and post-process wastes.[17] This was a major milestone for HP's product stewardship program; the company was able to demonstrate and qualify 25 percent recycled-content in a high-quality, cosmetic application. Meeting extremely tight color controls for this light-colored part was the biggest technical challenge overcome in the project. As a result, in 1995 more than 1.1 million pounds of recycled plastic were used in the DeskJet 850 printer series. When the recycled-content is incorporated into the entire 850C platform, HP estimates a diversion of six million pounds of plastic from the wastestream annually.

Access to a consistent supply of recycled resin, in terms of quality, quantity and cost, is a major issue. When HP embarked on this project, recycled plastic resin for this application was not even commercially available. HP research and development staff, design engineers, and procurement managers worked closely with resin manufacturers and injection molders to co-develop and qualify a usable recycled product and identify a reliable and steady source of pre-consumer and post-consumer scrap. In addition to meeting engineering specifications for color and performance, the recycled-content resin had to meet "parity" cost criteria.

Other HP product lines are exploring the use of recycled-content in plastic parts, although uncertainty in recycled-resin supply makes designers hesitant to specify recycled-content in new products and undergo costly and time consuming qualification and certification processes. With a projected increase in demand for recycled resin, one of the significant challenges ahead for manufacturers such as HP, the information technology industry in general and its resin suppliers, is building up the supply of recycled resin. For example, HP has difficulty getting their printers back from customers due to their long life and secondary market value. Building an effective plastics recycling infrastructure will require coordinated efforts among manufacturers, recyclers and resin suppliers to ensure product designs that facilitate plastics recycling, effective product recovery channels and improvement in plastics identification, sorting, and recycling technologies.

Toner Cartridge Recycling

Over the life of a printer, a customer may go through 50 or more print cartridges, amounting to a wastestream of cartridges and packaging that exceeds that of the printer itself. To facilitate recycling these "consumables," Hewlett-Packard has offered customers a program for returning toner cartridges for recycling. For LaserJet toner cartridges, customers return used cartridges in the original packaging using a pre-paid UPS label that is provided with the product inserts.

Cartridges are disassembled and over 98 percent of the cartridge by weight is recycled or used in the manufacture of new cartridges. As an example, the following is a breakdown for one cartridge model:

- 37 percent reuse of parts, such as screws, springs, clips, magnetic roller, and corona assembly.
- 38 percent parts remolded for use in new cartridges, including plastic housings.
- 24 percent materials recycled (e.g., some plastic parts and electronic assemblies) and sold to alternative markets for use in new products.
- 1 percent landfill disposal, including seals, foams, and adhesive labels.[18]

Since the program's inception in 1991, approximately 13 million cartridges have been recycled, at no cost to the customer. A similar return program is offered for InkJet printer cartridges through U.S. dealer networks, although reuse and recycling opportunities are limited by product technology.

Looking Towards the Future

To guide its environmental improvement efforts, in 1995 HP's InkJet Business Unit undertook a comprehensive life-cycle assessment (LCA) of its highest volume print cartridge. The LCA measured environmental impact in four categories: greenhouse effect, atmospheric acidification, natural resource depletion, and nutrification potential. Some expected and some interesting results emerged:

- Energy consumption of the cartridge during printing was very small compared to other life-cycle stages.
- A packaging change implemented in 1994 reduced by 15 percent the environmental impact in each of three categories. The packaging change led to a 35 percent reduction in packaging mass, doubling of shipping efficiency, and significant savings in manufacturing costs.
- Ocean shipping of cartridges from their manufacturing location in Singapore to the European market, instead of air transport, significantly reduces environmental impact, a change which has subsequently been implemented. Ocean shipping, combined with the packaging change, reduces resource depletion by more than one-third, and both global warming and acidification by about one-fourth.
- Paper use in printing and the energy consumed when the printer is idle, together account for almost 95 percent of all environmental impacts.

In addition to the changes in packaging and shipping already made, these LCA results establish clear priorities for future product stewardship efforts in the InkJet business. Possible improvements include, for example, double-sided print capabilities using hardware or software solutions, and a printer design that turns itself off after a specified period of non-use.[19] Cost savings in paper and energy consumption for customers clearly make these win/win proposals, demonstrating that environment and business objectives go hand in hand.

3.4 PRODUCT LIFE-CYCLE MANAGEMENT AT NORTEL

Nortel sees sound environmental management as a key contributor to customer and shareholder value. The company continually seeks to exceed mere compliance and to minimize resource consumption, waste and adverse environmental impact, limited only by technological and economic viability.

Nortel's Corporate Environmental Policy

Nortel (Northern Telecom), headquartered in Mississauga, Canada, is a leading global manufacturer of telecommunications equipment. The company provides equipment, services and network solutions for information, entertainment, and communications networks operated by telephone companies, corporations, governments, and other institutions worldwide. Major products include central office switches, private branch exchanges (PBXs), and wireless communications. Nortel operates in more than 90 countries, and employs over 60,000 people. Celebrating its centennial in 1995, Nortel reported revenues of U.S. $10.7 billion, of which 60 percent were earned in North America.

In 1992, Nortel initiated its Product Life-Cycle Management (PLCM) program which commits the company to factoring resource efficiency into all stages of the product life cycle. Similar to the programs of Compaq Computer and Hewlett-Packard, Nortel's PLCM program addresses supplier management, builds environmental improvement into the design phase of new products, and provides alternative solutions to product disposition. PLCM at Nortel also means reevaluating traditional manufacturing processes and technologies to design new, more efficient, as well as less toxic, products and processes.[20]

Nortel's approach to environmental management has evolved over time. Starting with end-of-pipe solutions and compliance in the 1980s, Nortel developed fundamental programs to address discrete sources of pollution for the protection of air, land, and water resources. Nortel is now moving towards more systematic and comprehensive approaches to addressing environmental issues. For example, the company adopted an Environmental Management System (EMS) standard, and with the PLCM program, it is actively moving beyond manufacturing operations to address the life-cycle environmental impacts of products.

Nortel is convinced that environmental excellence is excellent business. The company realized this first with chlorofluorocarbon elimination. Nortel saved four times its one million dollar initial investment over three years. Similarly, a business case on investment in environmentally-related programs developed in 1995 to support the pursuit of Nortel's environmental targets (see below) revealed an impressive 1:4 ratio of investment to return.

With its PLCM program, Nortel believes it can save money for customers and for the company, increase customer loyalty, and create value for their customers. This case addresses how efficient use of resources, such as reusable packaging, longer life products and asset recycling, saves money for Nortel and customers, while reducing environmental impacts. Nortel also believes that a segment of the marketplace will choose environmentally-preferable products.

Indeed, some large telephone operating companies, such as British Telecom and Telia Telecom, are querying suppliers about the use of hazardous materials in products and product recyclability.

3.4.1 Product Life-Cycle Management: From Design to End of Life

Nortel approaches its product life-cycle management program strategically. Consistent with corporate operating principles, the program aims to create customer value. Customer value takes many shapes, including: lower lifetime costs of products through resource efficiency; partnerships with customers to improve their environmental performance; and value-added recycling of products at the end of life. PLCM also strengthens strategic alliances with suppliers, which are of growing importance to Nortel's overall business strategy.

In support of its philosophy, Nortel created a new position, Corporate Director of Business Development in Environmental Affairs, to guide and stimulate PLCM efforts throughout the company. The mandate for this position is to improve the environmental performance of the corporation through changes in all stages of the product life cycle — design, supply management, manufacturing, marketing, distribution, and product disposal. Activities underway include, for example:

- Working upstream with suppliers to redefine responsibilities and requirements.
- Redesigning products to eliminate toxics and improve resource efficiency.
- Improving manufacturing operations through energy efficiency and research into the use of VOC-free fluxes and lead-free solders.
- Implementing packaging improvements that minimize wastes.
- Reducing environmental impacts at product end of life through recycling initiatives.

Nortel is also developing guidance and tools to help product and system designers integrate environmental considerations into systems of the future. In 1995, design guidelines were made available on-line to design engineers. Development of a set of PLCM standards for new product design is underway. Like any Nortel standard, compliance with these standards will be required as part of the product development process.

Over the next several years, Nortel will develop and phase in PLCM standards as the company acquires the necessary knowledge and experience to establish appropriate standards. Standards are currently proposed for:

- Life-cycle analysis, or eco-profiles.
- Hazardous material use (e.g., eliminating use of lead in manufacturing, brominated flame retardants in plastics, chromate metal finishes).
- Product packaging (e.g., volume reduction, reusable designs).
- Manufacturing emissions (e.g., reducing VOC emissions which account for 50 percent of hazardous air emissions at Nortel sites).
- Material reuse and recyclability (e.g., material selection, design for disassembly).
- Product take back.

The first series of standards will include eco-profiles, manufacturing emissions, and hazardous material use.

The eco-profile standard will assist Nortel staff in developing the necessary knowledge base to establish future standards. The eco-profile standard will require design engineers to characterize the product, identifying environmental issues and potential solutions throughout the life cycle, from technology, market and regulatory perspectives. Introduction of the eco-profile standard will occur over three years, starting with consumer products and followed by commercial equipment (e.g., PBX, Norstar) and infrastructure (e.g., switching, cellular) equipment. Information derived from the eco-profiles will serve as a management tool to establish Nortel PLCM standards and will help focus Nortel's research and development efforts. Eco-profiles might also be used in marketing and customer communications.

Measuring and communicating environmental performance is a priority for Nortel, and a requirement of their corporate EMS. The company is currently working toward four measurable targets for the year 2000, with 1993 as the baseline year:

- 50 percent reduction in total pollutant releases to the environment (land, air, and water).
- 50 percent reduction in solid non-hazardous waste.
- 30 percent reduction in paper purchases.
- 10 percent improvement in energy efficiency.

While these initial targets focus mostly on Nortel operations, additional product-related targets will be established over the next several years.

3.4.2 Results

Nortel's PLCM results demonstrate that environmental objectives are supportive of business objectives. To lower product costs, Nortel strives to root out inefficiencies and waste in the design, delivery, and use of its products. Energy efficiency is a major target. Study after study conducted by Nortel identifies energy efficiency as a major leverage point for environmental improvement of products and processes. More energy-efficient products translate directly into lower costs for customers, since energy is a major cost of operating telecommunications equipment.

Over the years, Nortel has made significant progress in reducing the environmental impact of manufacturing processes, including the elimination of CFCs and reductions of VOC releases. Under the PLCM program, improvements in manufacturing continue; for example, in 1996 Nortel's Research Triangle Park facility installed a new VOC-free process technology, developed by Nortel's own process development teams. Research and testing are also underway on lead-free solders and alternative circuit board coatings. Nortel's PLCM program, however, moves beyond manufacturing. Below are highlights of some of Nortel's initiatives to improve other aspects of the product life cycle.

Supply Management and Chemical Use Reduction

Nortel is investigating new business opportunities in supply management to help the environment and lower costs. In an effort designed to reduce chemical use, Nortel is embarking on an innovative business strategy with its chemical suppliers. In a pilot project at one of Nortel's Ottawa, Ontario sites, Nortel is initiating a new business relationship with its main chemical supplier. Under this new relationship both Nortel and its chemical supplier will have a joint incentive to reduce chemical use.

The hallmark of such a relationship is a change in the once competitive nature of the manufacturer/supplier relationship. Instead of the supplier seeking profit by encouraging Nortel to use more chemicals, under a "shared savings" relationship, Nortel and its chemical supplier will work together to minimize chemical use. In its long-term contract, Nortel purchases the services of the supplier for a fixed fee, rather than purchasing the chemicals themselves. Thus Nortel removes the financial incentive of the supplier to sell more chemicals. In this new relationship, the supplier is responsible not only for supplying the needed chemicals, but also for providing services such as chemical process expertise and chemical management, storage, and disposal. As a result, the supplier has the incentive to help Nortel minimize chemical use by introducing innovations, searching for alternatives to hazardous chemicals, suggesting more efficient chemical processes, and delivering only the quantity of chemicals needed.

Such a supply management relationship allows Nortel to concentrate on what it knows best — network solutions in the telecommunications industry — while leaving the chemicals to the experts. The ultimate impact is reduced chemical use and costs and increased quality in products and processes due to the leveraging of outside expertise. By inviting suppliers into such long-term business relationships, Nortel is developing an innovative solution that helps the environment and makes good business sense.

Extending Product Life Through Design

Nortel has adopted a modular product philosophy for its new Vista line of telephones, called Power Touch, in the U.S. The new model allows the customer to upgrade the unit without buying a new one and scrapping the old one. The principle driver behind the design was to create "user value" by leveraging the customer's initial investment through a flexible and upgradeable design. The new model is designed in two parts — a standard base with basic telephony features and an upgradeable slide-in module that can add features such as caller ID, call waiting, a larger screen size, or a better graphics display. The base holds its design for a longer period of time, while the module can be replaced to provide the latest features at half the cost of replacing the telephone. This new design minimizes product obsolescence and reduces the volume of product headed for recycling or disposal.

Long-life products are not new to the telecommunications industry, where equipment is typically in the field for 15 to 20 years. Nortel's Meridian office systems introduced in 1970s were "backwards compatible," which meant that even in the 1990s a customer can easily upgrade and expand to provide enhanced communication capabilities without replacing the entire system.

While the Meridian system was unique at the time, the architecture of new systems is increasingly modular in design to enhance upgradeability and expansion and to allow "plug 'n play" with any manufacturers' equipment.

New Packaging Concept to Reduce Waste

For Nortel, packaging was an obvious and early target for waste reduction, as legislation worldwide focused attention on this wastestream and disposal costs skyrocketed. Nortel established a North American packaging council in 1995, and expanded this effort to a world-wide packaging council in 1996, to promote returnable and recyclable packaging, and to assist Nortel sites in achieving the corporate target for reduction of non-hazardous solid waste.

As a result, packaging changes are springing up throughout Nortel, leading to significant cost savings and a 10 to 15 percent reduction in packaging volume. For example:

- Standardization and redesign of distribution packaging saves approximately $5 million annually. These savings were achieved by standardizing, and thus reducing the number of packaging configurations. The resulting reduction in the number of box configurations led to a greater reuse of boxes, the need for less storage space and sorting, and fewer boxes purchased.
- Shipping switching products in assembled mode, rather than packaging and shipping components separately for on-site assembly, saves an additional $5 million annually. The "plugs in place" shipping method requires less packaging and reduces installation time.
- Nortel designed a new "clamshell" packaging system for shipping circuit boards that eliminates cardboard and foam waste, and is reusable. The packaging is also designed to improve handling and storage for customers. The clear plastic allows customers to scan product bar codes without opening the packaging and risking damage to the product. The nesting and stacking feature of the clamshell design saves space on the production floor.

Asset Recycling

Nortel operates three recycling facilities in North America and one in the United Kingdom with a mission "to provide entrepreneurial solutions and services for the valued recovery of materials and surplus assets while demonstrating environmental leadership." To accomplish this mission, the reclamation operation provides Nortel divisions and customers with a full range of asset disposal and recycling services, such as equipment testing and refurbishing, resale of useable components, and recovery of precious and non-precious metals and plastics. The operation has a good profit margin: approximately 85 to 90 percent of the revenues are returned to business units, and even customers where applicable, while 10 to 15 percent cover operating costs.

Nortel's reclamation operations date back to the 1970s, when they opened a facility in Barrie, Ontario to provide an equipment recycling service to Bell Canada, a major customer. The facility primarily processed metal-based product, particularly copper, to achieve maximum separation and recovery value for Bell Canada. The origin of Nortel's U.S. reclamation facility in Durham, North Carolina was quite different; it started in 1990 as a central collection and disposal point for Nortel surplus assets such as desks and other non-telecom office equipment. Today, however, the Durham facility handles mostly telecommunications equipment, and is the central return point for Nortel products coming back from the field.

In the U.S. and Canada, the reclamation operation processes 50 million pounds of equipment annually, including central office switches, private branch exchanges, and cable and components from excess and obsolete inventory. About 50 percent of the equipment processed is Nortel's own equipment and excess and obsolete inventory. Trade-ins and removal from customer sites account for the other 50 percent, although Nortel is actively trying to expand services to commercial customers and suppliers. In the United Kingdom, for example, Nortel negotiated with British Telecom to take back some older varieties of PBX equipment for reuse and recycling. In addition, Nortel is working with other European distributors to develop tailored Product Take Back (PTB) services to suit distributor and market conditions.

Over 90 percent of the equipment processed at the facilities (by weight) is recovered for reuse or recycling. Product and component reuse and resale (e.g., circuit boards, memory chips, line cards) account for approximately 50 percent of revenues, playing a greater role today than in the past. Three years ago at the Barrie, Ontario facility over three-quarters of the equipment was electro-mechanical or copper-based cable, which was granulated or shredded to recover metals. In contrast, today more than half of the equipment is processed for reuse and resale. There are two reasons for this. First, the value in the recovery of raw materials is declining due to a reduction in the precious metals content of the products processed at the facility. Second, technology is moving at a faster pace, which results in a greater rate of equipment turn over. While the equipment might be obsolete by some customers' standards, it may still be functional or contain reusable parts.

The amount of material going to landfill has decreased from ten percent to four percent over the past several years as a result of a zero landfill program aimed at reducing solid waste disposal costs. (The goal for 1998 is only two percent to landfill.) The zero landfill program identified alternative disposal options and reuse opportunities for materials going to landfills. One wastestream targeted was pallets. The solution in this case was to route the pallets back to the business units for reuse, rather than disposing of them. In addition to saving landfill costs, this program saves the business units approximately $70 on the purchase of each new pallet (after inspection and redistribution costs). As a result of the zero landfill program, disposal costs at the Durham facility were reduced approximately 90 percent from 1992 to 1994.

3.5 CONCLUSIONS

The companies highlighted in this case study are just a few of the many electronics companies undertaking EPR initiatives. Similar activities are underway at Xerox Corporation (see Chapter 7 of this report), IBM, Lucent Technologies (formerly AT&T), Digital Equipment, and Dell Computer, to name a few. Common elements among these companies are a focus on product design for environment, supplier management, and improved asset management and recycling. As illustrated in this case study, the design and implementation of EPR programs is uniquely suited to each company and its culture and operating norms, although each company is working towards integration of EPR program elements into the business units.

Table 3-5 provides an overview of EPR initiatives underway in the electronics industry. There are good business reasons for undertaking such initiatives. Indeed, the companies interviewed for this study each emphasized that "if it doesn't make economic sense, it is not going to happen." The examples highlighted in this case demonstrate the convergence of environmental and business performance objectives, for example:

- Upgradeable designs can slow product obsolescence, increase customer loyalty, lower cost of product ownership, and improve product serviceability.
- Designing products with reuse and recycling in mind can lead to lower manufacturing costs and improved manufacturability due to parts consolidation and reduction in material variety.
- Energy efficient products reduce operating costs.
- Extending product life through asset management strategies can improve the service function, lower disposal costs, create new revenue streams, and introduce products to new markets.

Table 3-5: EPR Initiatives in the Electronics Industry

More Efficient Use of Energy and Material Resources
- Greater or same functionality using less materials (by weight).
- Reduced power consumption through Energy Star products.
- Reusable transport packaging.
- Reduction in packaging materials.
- Selling functionality or service instead of products (e.g., call answering service).

Pollution Prevention
- Elimination of CFCs in manufacturing operations.
- Lead-free solders.
- VOC-free fluxes.
- Removal of brominated flame retardants from plastics.
- Removal of heavy metals from packaging materials.

Reuse and Recycling
- Reusable transport packaging.
- Recycled content in packaging and products.
- Product design for recycling (e.g., reduced material variety, use of recyclable materials, plastics identification).
- Equipment demanufacturing, component reuse, and materials reclamation.
- Rechargeable battery recycling.

Extending the Useful Life of Products
- Improved asset management, including product redeployment, remanufacture, equipment conversion, and recycling.
- Product design for upgrades, expansio, and serviceability.
- Recovery of service parts from used equipment.
- Lease-based programs.

Successful implementation of most of these initiatives, however, is highly contextual, subject to myriad product and market variables that must be sorted out on a company-by-company, product-by-product basis. This is particularly true for product recovery and recycling, where product technology, configuration, components, and material composition influence end-of-life opportunities and value. The economics of product recycling is determined further by recycling markets (and their volatility) and recovery infrastructure.

This is just the beginning of EPR in the electronics industry. The companies highlighted in this study are in the early stages of program implementation. We can fully expect continued progress as more and more companies and business units within these companies realize the economic advantages of EPR programs and begin to focus their creativity and competitive spirit on eco-efficiency throughout the product life cycle. The challenge for public policy will be in monitoring these developments and recognizing where economic incentives are absent and government intervention is needed.

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CHAPTER 4

THE FRIGIDAIRE COMPANY'S PROGRAM FOR RECYCLABLE PRODUCT DEVELOPMENT OF REFRIGERATORS

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"Our goal is to become the leader in environmentally sound technology."

Lief Johannsen, Electrolux Environmental Mission Statement

4.1 INTRODUCTION

The appliance industry has long been the focus of environmental concerns and pressures. Household appliances consume 12 percent of the energy and 34 percent of the electricity used in American households.[1] Lack of recycling infrastructure led to illegal dumping of appliances (also known as white goods), and hazardous constituents in older appliances, such as mercury and PCB-contaminated capacitors, created a perception of appliances as a problem waste. Concerns about the shrinking ozone layer have required manufacturers to look for adequate substitutes for ozone depleting substances. Appliances comprise one percent of the municipal wastestream in the U.S., with approximately eight million used appliances discarded annually. While the current recycling rate for appliances is around 62 percent (by weight), many appliances still wind up in landfills, where they take up valuable space. These issues and others have spurred 16 states in the U.S. to ban appliances from landfill disposal,[2] and several countries in the European Union to mandate take back, disassembly, and recycling of used appliances.

In light of environmental regulations and public pressure, many major manufacturers in the appliance industry are moving towards voluntary EPR. Manufacturers realize that even in the U.S. they may ultimately share responsibility for the disassembly and recycling of their products. In order to make product recycling simpler for the existing recycling infrastructure, manufacturers are working on making appliances more recyclable. According to Frigidaire Company President Hans Backman, the "industry will now aggressively design products up front for environmental considerations, including design for disassembly and recyclability — environmental concern will be become a product design specification."[3] Frigidaire is including environmental considerations in product development as it moves towards the year 2000.

4.2 FRIGIDAIRE COMPANY — BACKGROUND

The first refrigerator under the name of Frigidaire was sold in 1918. Since then, Frigidaire has been a pioneer in appliance manufacturing in North America; among Frigidaire's inventions are the electric self-contained refrigerator, the home food freezer, the room air conditioner, the window air conditioner, the vertical pump agitator washer, and the refrigerator-freezer combination.[4] In 1979, Frigidaire was purchased by White Consolidated Industries (WCI), which owned several other appliance lines, such as Gibson, Kelvinator, White-Westinghouse, and Philco. WCI had registered sales of $2.06 billion annually, with 76 percent of total sales from their Home Products Division.[5]

In April, 1986, WCI was acquired by AB Electrolux of Sweden, making Electrolux the largest global manufacturer of appliances. In the resulting restructuring, the WCI Major Appliance Group was renamed the Frigidaire Company.[6] Frigidaire produces five product brands in the U.S.: Frigidaire, Gibson, Kelvinator, Tappan and White-Westinghouse, at ten manufacturing facilities in North America.

4.3 BACKGROUND OF DECISION TO IMPLEMENT EPR

Frigidaire's parent company, Electrolux AB, has emerged as a leader in environmental product development. The company's Environmental Mission Statement from is expressed as follows:

> Our goal is to be the leader in environmentally sound technology. The fact that we sell about 40 million units per year in white goods alone means that we have to have commitment to the environment. But it also offers an opportunity to exert an influence and make a positive contribution. Reduced consumption of resources and systems for recovery and recycling will help to alleviate the problem of waste and increase the potential for conservation of valuable raw materials.[7]

Electrolux is committed to minimizing the impacts of refrigerators and freezers on the environment, while seeking to meet the highest safety and efficiency requirements throughout the entire life cycle of the products.[8] In Sweden, Electrolux is a signatory of the ICC Charter on the Environment, and operates a take-back and recycling program for its scrapped products in Stockholm as part of its environmental commitment.[9] In 1994 Electrolux completed the transition from chlorine-free R134a to cyclopentane as a foam blowing agent in refrigerators and freezers for the European market, as well as shifting from R134a to isobutane as a refrigerant. Their department of Research and Innovation is working on completing life-cycle assessments and guidelines for "environmentally-friendly" product development. A number of products, including white goods, vacuum cleaners, and chain saws have already been analyzed from a life-cycle perspective. Electrolux is also producing a new type of vacuum panel for thermal insulation in refrigerators. The panels are totally recyclable, and the insulating properties of the panels enable a reduction of energy consumption of up to 18 percent.[10]

While the environmental stewardship mission of its parent company has created an impetus for greater product responsibility for Frigidaire, federal and state legislative initiatives have also driven Frigidaire to action. Improvements in energy efficiency are required of the industry under U.S. Department of Energy standards set by the 1987 National Appliance Energy Conservation Act and the 1992 Energy Policy Act. Under these energy standards, manufacturers were to make efficiency improvements of 32 percent over 1990 efficiencies, with additional requirements of another 25 percent reduction set for 1998.[11] State initiatives, such as landfill bans and advance disposal fees on white goods, have also prompted Frigidaire to improve the recyclability of refrigerators. Table 4-1 describes state bans and fees for white goods.

Table 4-1: State Policies on White Goods

State	Landfill Disposal Ban	Advance Disposal Fee
California	T	
Florida	T	
Hawaii	T	
Illinois	T	
Louisiana	T	
Maine	T	$5, on retail sale
Massachusetts	T	
Minnesota	T	
Missouri	T	
Nebraska	T	
North Carolina	T	$10 w/CFCs; $5 otherwise
Oregon	T	
South Carolina	T	$2, on wholesale
South Dakota	T	
Vermont	T	
Wisconsin	T	

Sources: Steutville, 1995.

Guided by Electrolux's vision statement, the Frigidaire Company has adopted environmental policies and plans to drive progress in product development, processes, and workplace issues. Product evaluation teams are established with cross-functional representation and participation from several departments, including engineering, marketing, quality, and purchasing. All new product lines are evaluated for environmental factors including recyclability, materials usage, energy usage, and environmental impact. The Company considers these factors to be an important aspect of good business.[12]

Frigidaire has set a goal of having a more recyclable product line by the end of the 1990s. This is to be accomplished through enhancing the recyclability of existing products and design for recycling of future products, without sacrificing performance or increasing manufacturing costs. Enhancing the recyclability of existing products will entail recyclability assessment, materials consolidation, and labeling. A second phase will involve better interaction with suppliers and recyclers to: 1) use more recycled products in refrigerators; and 2) find future uses for the materials in disposed products.[13] This case study describes activities to date under the Frigidaire program, changes in the product, and future plans. Specific environmental initiatives at the Refrigeration Products Plant at Greenville, Michigan, are highlighted, followed by discussion of company-wide activities.

4.4 CURRENT STATUS OF PROGRAM

Changes in public and environmental perceptions of appliances have led to many technological advances in appliance design and manufacturing. Appliances are being designed to be CFC-free, more energy-efficient, more recyclable, and less noisy.

4.4.1 Refrigerator Recyclability Assessment and Improvement

In keeping with industry trends, in the Spring of 1994, Frigidaire began a Refrigerator Recyclability Assessment at its Refrigeration Products Plant in Greenville, Michigan, with a goal of developing a more recyclable refrigerator.

Product Teardown

First, teardown of a refrigerator was performed to determine how long it would take a two-person team to disassemble a common refrigerator model. The teardown was accomplished manually with hand tools and a power saw. The goal was strictly to assess recyclability of a refrigerator; when and if disassembly of appliances is done on a large-scale in the U.S., it could be accomplished through a combination of automated and manual disassembly, as is done by Electrolux in Europe. The team took approximately 32 minutes to tear down the majority of the unit, with exception of the liner-foam-cabinet sandwich, which required quite a bit more time to take apart.

Several conclusions were drawn from the teardown:

- While all the metals could easily be identified, not all plastics could be identified.
- Too many types of plastics were being used.
- The liner-foam-cabinet sandwich required the most time to disassemble, and comprised most of the units' mass.[14]

Materials Consolidation

Based upon findings from the teardown, Frigidaire decided to consolidate several of the plastics used in their refrigerators. Frigidaire consolidated three types of clear plastic that were being used in the clear portions of the refrigerator, such as the bins, containers, drawers, and shelves. The three plastics, polymethyl methacrylate, clear acrylonitrile/butadiene/styrene, and polyester, came from three different suppliers. Rather than using one of the existing plastics exclusively, Frigidaire decided to use a polycarbonate that achieved the "water clear" look desired for interior bins, etc. The change in materials resulted in improved part quality, as well as achieving a ten percent reduction in materials price due to purchasing a larger volume of material from one supplier as opposed to three.[15]

Parts Reduction

Frigidaire had great success with parts reductions in the handle and trim of their refrigerator doors. Based on results from the refrigerator teardown, Frigidaire felt that a substantial reduction in the number of parts in the handle assembly could be accomplished without decreasing performance or aesthetics. The design change resulted in a reduction of 58 parts to 20 parts. The new handle is also more recyclable because it is made out of a fewer number of plastics. Further, the parts reduction substantially reduced the assembly labor, time, and space requirements, as seen in Table 4-2. Implementation of the parts reduction resulted in materials savings of 77 percent, and a labor savings of 64 percent.[16]

Table 4-2: Comparison of Original vs. New Refrigerator Handle Assembly

Side-by-Side Refrigerator	Old	New	Difference
Number of parts	58	20	38
Labor (# of people)	17	4	13
Assembly time (min.)	8.1	1.9	6.2
Assembly space (sq. ft.)	425	100	325

Source: Paul Nash, Frigidaire.

4.4.2 Conversion to Organic Powder Paint

In late 1994, Frigidaire decided to replace the existing high-solids paint system. The company believed it could obtain a better finish and more corrosion protection through switching to an organic powder system, while also realizing significant environmental advantages in elimination of solvents.[17] Powder paints are powdered resins which are applied to a substrate (in this case, a refrigerator or freezer) and heated to fuse the resin into a uniform, continuous film. Results of the new powder paint line include:

- Film thickness in the 1.5 - 1.7 mil-range.
- Transfer efficiency in the range of 95 - 98 percent, compared to 70 percent with the high-solids system.
- Line speed of 24 ft/min.[18]

There have been multiple benefits from the conversion. The switch to the powder paint formulation removed the use of caprolactum in refrigerator and freezer paints. Further, the elimination of solvent borne painting operations has reduced annual factory emissions by more than 2.2 million pounds.[19] The new powder paint lines have been installed for refrigerator doors at the Greenville, Michigan and Anderson, South Carolina facilities, as well as in five other Frigidaire manufacturing facilities.[20]

4.4.3 Packaging Program

Frigidaire has also instituted a Returnable Reusable Container (RRC) program. The RRC goal was to have 80 percent of internal packaging be returnable and reusable. This goal was accomplished in cooperation with suppliers and transporters. Concentrating on replacing wooden pallets, paper dunnage and corrugated cardboard, Frigidaire purchased reusable polyethylene pallets, dunnage and containers, marked for use with specific suppliers. The empty containers are back hauled by suppliers upon making deliveries. At the Greenville facility alone, the RRC program has complete participation of eligible suppliers, and saved over $3 million since 1994.[21] Company-wide, the Frigidaire RRC is the largest packaging reduction program in the industry, with estimated environmental savings of 10,431 cubic yards of landfill space annually.

4.4.4 Plastics Marking

The increased use of plastics in appliances has complicated appliance recycling, much as it has for other durable products, such as automobiles. As plastics use increases, so does the amount of shredder residue, or "fluff," that is generated when appliances are shredded. To combat these problems, manufacturers have been looking for potential solutions to make plastics more recognizable, separable, and recyclable.

As early as 1992, Frigidaire began to mark plastic parts by resin type to aid in recycling of plastic parts. Using the ISO 1043 system, Frigidaire began labeling all plastic parts and packaging in an effort to enhance their future identification and the disassembly process of discarded major appliances. Polymer and filler contents for all plastic parts with an approximate weight greater than four ounces are marked.[22] A primary concern in development of the plastics labeling initiative was to mark parts in an easily accessible location without hindering the performance and aesthetics of the part. The system developed by Frigidaire to accomplish this has become the industry standard.[23]

Frigidaire also has an active voluntary program to eliminate polyvinyl chloride (PVC) in several product lines. Interest in reducing PVC is primarily due to an initiative from Electrolux to remove PVC from all European product lines. Currently Frigidaire is working with Dow to test polyethylene gaskets as an alternative to PVC gaskets in refrigerator door seals.

4.5 OTHER FRIGIDAIRE INITIATIVES

Frigidaire is also working towards a second phase which translates their product recyclability improvements into product recycling; in this way, Frigidaire can ensure that the materials from disposed products can be reprocessed and resold for future use. While Frigidaire is not directly involved in take back of used appliances, the company is working with its suppliers, processors and manufacturers, as well as with representatives of consumers, dismantlers, and shredders to assist in developing a more recyclable product. In particular, as more plastics are used in appliance manufacture, Frigidaire is working to better develop the plastics recycling infrastructure.

As part of their commitment to product recycling, Frigidaire is a member of the Major Appliance Resource Management Alliance, or MARMA. Created in 1995, MARMA is a coalition of the Association of Home Appliance Manufacturers, the American Plastics Council, the Institute of Scrap Recycling Industries, the American Iron and Steel Institute, and representatives of the individual North American appliance manufacturers. MARMA's mission is to actively promote environmentally sound and sustainable management of material streams generated from the disposition of major home appliances. This mission is to be accomplished by:

- The promotion of the effective collaboration of organizations actively engaged in the material supply, appliance design and manufacturing, and resource management (including recycling).
- Identification and implementation of projects that: 1) acheive short- and long-term improvements in the management of materials generated by the disposition of appliances; and 2) assure the long-term viability of existing and evolving recycling infrastructures.
- Development of a system so that members can effectively collect and communiciate critical information needed to efficiently manage the materials available in major appliances and serve as a basis for sustainable appliance resource conservation policies, laws, and regulations.[24]

4.6 CONCLUSIONS

The appliance industry in the U.S. is beginning to move towards designing major appliances with less environmental impact. While past improvements have been based on state and federal government mandates, the industry is voluntarily implementing policies and design changes to make appliances easier to disassemble and recycle and more energy efficient. Much of this trend within the appliance industry is predicated on the increasingly global nature of the appliance industry and changes that are being required in European and Asian markets.

The Frigidaire Company is actively working to make its refrigerators more recyclable by enhancing the ease of disassembly, reducing parts and material used, and using materials that are more readily recycled. Frigidaire is not considering, at present, take back of used appliances. Recent studies have shown that over 60 percent of the overall product weight of appliances is currently recycled in the U.S. Given these rates of recovery through the traditional recycling infrastructure, Frigidaire feels there is no need to actively consider industry take back of appliances in the U.S. Instead, Frigidaire is concentrating on working with other industry members and trade associations to increase the recovery potential of plastics in major appliances. This is being pursued by working with plastics suppliers to help drive up plastic recycling rates and develop more efficient plastics recovery technologies.

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CHAPTER 5

AUTOMOTIVE TAKE-BACK AND RECYCLING PROGRAMS

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5.1 INTRODUCTION

This case study focusses on the automobile industry, probably the most significant industry sector in the U.S. economy. The life cycle of the automobile incorporates many other major industry sectors: petroleum, steel, aluminum, chemicals, plastics, synthetic fibers, glass, and electronics. The automobile industry is also unique in that it has long been focussed on extending environmental responsibility for its products beyond the manufacturing stage. Because the use stage of the automobile is a significant source of environmental impacts, with estimates that 80 - 90 percent of energy use, for instance, occurs during use,[1] the automobile industry has had particular focus on the use stage. Fuel efficiency standards and air emission standards have been the drivers for significant improvements in the environmental performance of the product during use.

The automobile industry also exerts tremendous influence on its supply chain. For many of its suppliers, the automobile industry is, by far, the largest customer. Therefore, it is no surprise that when automobile assembly plants have to deal with an environmental issue, such as emissions from painting, their suppliers are eager to partner with the auto companies to solve the problem in a life-cycle partnership by redesigning or reformulating the product. There are many examples of extended product responsibility in the automotive industry that are directed at the supply chain, which are beyond the scope of this case study.

This case study focusses on the end-of-life stage of the automobile. It discusses the overall industry response to the various pressures on the industry to increase recycling, particularly for the plastics increasingly used in the automobile. While there are numerous recycling initiatives that have been launched by U.S. automobile companies, this case study highlights two recycling initiatives that attempt, for the first time, to retrieve and recycle plastics from end-of-life vehicles into new vehicles.

5.2 PROBLEM AND INDUSTRY RESPONSE

The automobile is one of the most recycled products in the world today, but the sheer number of end-of-life vehicles makes the remaining wastestream, which is primarily disposed of in landfills, a high priority for recycling efforts. The automotive industry and its suppliers in the U.S. have responded to market pressures at home and regulatory pressures abroad by beginning to create Extended Product Responsibility programs to reduce the portion of the car sent to landfill.

5.2.1 The Auto Shredder Residue Problem

Approximately 12.2 million passenger and commercial vehicles were produced in the U.S. in 1994, and about 10 - 11 million vehicles are taken out of service each year.[2] The predominant method of dealing with end-of-life vehicles in the U.S. involves dismantling, shredding, and recycling of steel and aluminum. Dismantlers remove high-value parts for reuse and reconditioning. Shredders shred the auto hulks to recover ferrous and non-ferrous metals, which are sent to recycling mills. It has been estimated that 94 percent of the cars and trucks at the end of their useful lives is currently returned to dismantling and shredding facilities for recycling where approximately 75 percent of the vehicle, by weight, is recycled. With the number of automobiles, however, the 25 percent of the vehicle that is not recycled represents a major solid wastestream. This wastestream, which is composed primarily of plastics and fibers, is called auto shredder residue (ASR) or “fluff.” About 2.5 to 3.0 million tons of this waste are disposed of in solid waste landfills each year in the U.S.[3]

While there are no general restrictions on the land disposal of ASR in the U.S., and ASR is generally classified as non-hazardous waste, increasingly stringent regulations for municipal solid waste landfills have increased ASR disposal costs while reducing landfill capacity. Furthermore, ASR has, on occasion, failed the toxicity characteristic test for hazardous waste due to heavy metal contamination, and at least one state, California, has classified ASR as hazardous waste. Hazardous waste designation dramatically increases ASR disposal costs by requiring management in licensed hazardous waste facilities.

At the same time that ASR disposal has become more expensive and disposal capacity has declined, automotive manufacturers have turned more to plastics to reduce vehicle weight for fuel efficiency gains. This, in turn, has increased the percentage of ASR from shredders. Plastics content in an average vehicle in the U.S. increased nearly 50 percent between 1976 and 1992. With the steady reduction in readily recoverable metals combined with increasing landfill costs for ASR, some predict that the economic viability of the automobile shredder industry will be threatened.[4]

5.2.2 Proposed U.S. Legislation

The U.S. House of Representatives proposed legislation in 1991 that was seen by the automobile industry as the harbinger of mandatory recycling. H.R. 3369, called the Automobile Recycling Study Act of 1991, was introduced by Representative Torricelli of New Jersey but did not pass and was not reintroduced in subsequent Congresses. Included in the findings of the bill was the statement:

> Automobile manufacturers must work in tandem with the producers of raw materials for automobiles, materials suppliers, the automotive dismantling industry, the scrap processing industry, chemical process engineers, and the recycling industry to develop a more recyclable automobile.

The bill would have required a study by the EPA, in cooperation with the Department of Transportation and the Department of Commerce, on the potential for increased recycling of automobile components in the U.S. and the steps needed to increase such recycling. The study would have included "methods for incorporating recyclability into the planning, design, and manufacturing of new automobiles" and the "feasibility of establishing design standards for automobiles that would result in a gradual phase-out of hazardous and nonrecyclable materials used in automobiles."

5.2.3 European Regulations

Faced with even more pressing problems of diminishing landfill space and increasing quantities of ASR, European governments have taken action to increase recycling of the automobile through new regulations based upon the principle of Extended Product Responsibility. The European regulations are an outgrowth of the approach that the German government took with packaging (i.e., requiring consumer product distributors to take responsibility for recycling the packaging of the products they sell). The German government proposed a similar rule for the automotive industry in 1992 that would have required auto manufacturers selling cars in Germany to take cars back at the end of their useful lives and to recycle a higher percentage of the materials back into new automobiles. That proposal has been supplanted by a recent voluntary agreement among auto manufacturers, auto scrappers, and the German government. Although the proposed rule has been supplanted, it has had an effect on auto recycling programs worldwide during the past four years.

The proposed Scrap Car Rule would have explicitly extended automobile manufacturers' responsibility for their products. It had the following goals for manufacturers:

- Developing, designing, and producing automobiles and automotive parts and accessories that have a service life of "as long as possible" and that can be easily disassembled for reuse or material recycling.
- Using materials that facilitate material recycling and that are marked in a uniform way so that they can be disposed of in an environmentally compatible way if material recycling is not feasible.
- After disassembly, reusing parts in automobile manufacture or as spare parts or, for parts that cannot be reused, recycling the materials back into the manufacture of new automobiles.

The draft rule also set out take-back mandates which included requirements that:

- The automobile producer must take its cars back from the last owner at the end of their useful life “principally” free of charge.
- The withdrawal network must be at least in equal density to the sales network and have one withdrawal place or one pick-up system for each area engaged in disposal, even where there are no marketing offices of the automobile brand concerned.

Table 5-1 shows the reuse or material-recycling goals for the draft Scrap Car Rule.

Table 5-1: German Draft Scrap Car Rule Goals for Material Reuse or Recycling Back Into the Automobile

Material	Reuse or Recycling Goal for 1996 (%)	Reuse or Recycling Goal for 2000 (%)
Steel	about 100	about 100
Non-ferrous metals	85	90
Plastics	20	50
Tires	40	50
Other elastomers	20	30
Glass	30	50

The draft rule allowed producers or sellers of automobiles to use third parties to act on their behalf. Annual reports would have been required to show progress toward the recycling goals.[5]

As a result of the proposed rule, the automobile industry in Germany launched aggressive efforts to increase recycling in order to demonstrate that a voluntary industry approach can accomplish the goals of the regulation. The commitment of the automobile industry in Germany to recycling and certain political changes in the German federal government resulted in the replacement of the draft Scrap Car Rule with a voluntary agreement in March 1996.

The “Voluntary Pledge Regarding the Environmentally Compatible Management of End-of-Life Vehicles” pledges the following:

- The automobile industry will take the lead in setting up a national infrastructure of certified dismantlers for taking back and recycling end-of-life vehicles from their last owners free of charge for automobiles produced after March 1996 that are 12 years old or less.
- The reduction in ASR sent to landfills from approximately 75 percent by weight of the vehicle to a maximum of 15 percent by weight of the vehicle by 2002 and a maximum of 5 percent by 2015, with incineration with energy recovery as an option.
- The recycling-oriented design of vehicles and their components.
- The treatment of end-of-life vehicles in a manner that is compatible with the environment, particularly with regard to removal of fluids and dismantling, including more stringent environmental standards for dismantlers and shredders.

- The development and optimization of materials loops and facilities for recovery, especially for shredder residue, in order to reduce demands on landfill capacity and natural resources.

Other European nations also have policies and regulations to promote greater recycling of the automobile. The Netherlands has set up a quasi-public company, funded by a fee on new automobiles, to take back end-of-life vehicles and increase recycling, and Sweden adopted a system in 1996 which will give automobile manufacturers more responsibility for recycling. In addition to these national policies, the European Commission is considering a European Union-wide directive on end-of-life vehicles that would allow some flexibility in implementation by EU member nations. The draft directive would require manufacturers to arrange for take-back of end-of-life vehicles free of charge and to recover 85 percent of the automobile for all models by 2002 (90 percent for new models) and 95 percent by 2015. In contrast to the German Voluntary Pledge, the draft directive would curtail the use of incineration of ASR with energy recovery to meet these goals, requiring at least 90 percent of the recovery by 2015 to be material recycling and not energy recovery.[6]

5.2.4 General Response From the U.S. Auto Industry

U.S. companies are responding to European regulations in four ways. First, they are preparing to comply with them in their European manufacturing and sales operations. Second, they are importing some of their experiences with increased recycling in Europe back to the U.S. Third, they are attempting to preempt the necessity for such regulations in the U.S. by demonstrating voluntary progress in recycling. Fourth, they are responding to competitive marketing pressures from European manufacturers, who were forced to institute early recycling efforts, in a U.S. market that is anticipated to stress recycling as a market attribute in the future.

One collective response from the U.S. industry was the creation of the Vehicle Recycling Partnership (VRP) in 1991 to promote and conduct research required for the technology to recover, reuse, and dispose of materials from scrap cars. The VRP is currently part of the United States Council for Automotive Research (USCAR), formed by GM, Ford, and Chrysler in 1992 to strengthen the technology base of the domestic auto industry through cooperative precompetitive research. The objectives of the VRP are to understand issues involved with vehicle recycling; interact with other researchers; conduct research and development of technologies and methods to recycle materials and components from scrap cars; and develop guidelines for design and material selection to facilitate recycling. One major project of the VRP is the Vehicle Recycling Development Center, established in 1993 as the first Big Three joint research facility. This Center works on dismantling scrap cars and is currently running at about two cars per day to facilitate the various research projects, which include fluid removal and recycling, economic analysis, resin identification, seat and foam recycling, glass recycling, carpet and interior trim recycling, and instrument panel and bumper recycling. In each of these projects, the VRP has reached out to the supply chain or to dismantlers, shredders, and recyclers for information and assistance. Finally, the VRP is working with the American Plastics Council on developing pyrolysis technology to decompose plastic wastes to a hydrocarbon gas and oil that can be used as a feedstock to produce new plastics.[7]

5.3 FORD BUMPER TAKE-BACK AND RECYCLING PROGRAM

5.3.1 Extended Product Responsibility at Ford

Ford Motor Company's Manufacturing Environmental Leadership Strategy contains the following goals reflecting a commitment to Extended Product Responsibility: 1) "prevent pollution at the early stages of process and product development; 2) reduce or eliminate use of materials of concern; 3) promote and plan for recyclability; and 4) obtain supplier support and involvement." Some highlights of Ford's implementation of these goals include Ford's Substance Use Restrictions, which specify substances to be restricted in or excluded from parts and materials supplied to Ford; Ford's Worldwide Recycling Guidelines to increase the use of recycled content and the recyclability of the materials used in the automobile; and an across-the-board target by Ford to achieve a minimum 25 percent post-consumer recycled content of the plastic materials used in Ford cars. The Recycling Guidelines are specific directions to designers and suppliers on materials selection with recycling in mind. For instance, the Guidelines recommend against the use of multi-layer materials covered with cloth and recommend that metallic fasteners be made from ferrous materials to facilitate magnetic separation after shredding.[8]

The Ford bumper take-back and recycling program described below is one specific instance of Ford's promotion of recyclability. Other Ford recycling projects include the use of more than 50 million recycled PET bottles to make parts of the front grill, luggage racks, and door padding for new vehicles, and recycling approximately one million scrap polypropylene battery cases per year into splash shields for 325,000 cars.[9]

5.3.2 Program Description

The Ford take-back and recycling program for bumpers has evolved from unique partnerships between Ford and its material supplier, GE Plastics, and between Ford and an automotive plastics recycler, American Commodities, Inc., as well as a network of automotive dismantlers. Bumper recycling has been practiced commercially in Europe for several years, particularly by Ford.[10] Ford started its bumper recycling program in the U.S. in 1993 as a pilot program to recycle plastic bumper material into tail light housings. Today the program is recycling bumper material back into bumpers.[11]

Since around 1986 most Ford bumpers have been made of Xenoy resin, an engineered plastic produced by GE Plastics. Xenoy is a blend of polyester and polycarbonate resins, which is well-suited for use in bumpers because of its strength and flexibility throughout the range of conditions faced by automobiles.[12] Ford currently manufactures approximately 7,000 bumpers per day.[13]

The bumper take-back and recycling program began with an arrangement between GE Plastics and Ford to test bumper recycling at Ford's Atlanta assembly plant. Ford began by using material salvaged from Ford plastic bumpers from Taurus, Sable, Tempo, Topaz, Aerostar, Escort, and Tracer models to mold new tail light housings for the Ford Taurus and Mercury Sable wagons. Each recycled bumper yields about 30 new tail light housings. The plastic bumpers were converted into clean plastic flake, which GE Plastics regenerated into pellets. The recycled resins were molded into tail light housings by Ford's Sandusky, Ohio plastics processing plant.[14] Ford found that the tail light housings made from recycled bumper material met stringent quality and safety standards while costing less to produce.[15]

In the pilot program GE Plastics took post-use Ford Xenoy bumpers from Ford dealers and bumper shops and from automobile dismantlers and supplied them to a plastics recycler, Recycling Separation Technologies, Inc., of Lowell, Massachusetts. The purified regrind was sent back to GE Plastics, which recompounded it and sold it to Ford for reuse.[16]

Ford also began a partnership in 1992 with American Commodities, Inc., a plastics recycler from Flint, Michigan. At first, American Commodities recycled plant scrap for Ford before approaching Ford to participate in the bumper recycling program.[17] The company had developed a process for paint removal from Xenoy plant scrap and expanded that process to make it applicable to the variability of post-consumer bumpers.[18] American Commodities reprocesses post-use bumpers into compounds called Enviralloy, which Ford reuses in new automobile parts, using proprietary technologies to remove up to 99.7 percent of paint residue and to "rejuvenate" and enhance material properties.

In order to collect bumpers for recycling American Commodities has developed a network of 400 dismantlers across the country for the take-back program and has provided them with a written specification on methodologies for dismantling and product identification.[19] The company pays dismantlers $4.00 each for the bumpers and has 25 - 30 regional collection points for transport of the bumpers to the American Commodities recycling plant.[20]

5.3.3 Current Status of Program

The bumper recycling program currently recycles bumper material into new bumpers and is recycling approximately 1.5 million pounds of Xenoy plastic per year.[21] Ford is not currently using recycled Xenoy from GE Plastics, but is relying entirely on American Commodities for its supply.[22]

Ford found that greater cost savings were achieved in recycling bumper material back to bumpers, instead of tail light housings, because the virgin Xenoy material for bumpers is more expensive than the virgin ABS material that has traditionally been used by Ford for tail light housings. As of 1995 Ford began making guide brackets (a non-crash component) for new bumpers using 100 percent recycled Enviralloy from American Commodities. In 1996 Ford began using 25 percent recycled Xenoy in new Xenoy bumpers for box beam applications. The recycled material is currently being used for Contour and Mystique bumpers.[23] Ford is also planning to use recycled Xenoy at a rate of approximately 0.5 million pounds per year in service parts for bumpers for all models of Ford cars.[24]

American Commodities collects and recycles more Ford bumper material than is currently reused by Ford. The company is currently recycling 6 - 8 million pounds per year and sells the recycled material Ford does not use to other manufacturers. The material is sold at a 25 - 30 percent cost savings as compared to virgin Xenoy.[25]

5.3.4 Drivers For and Benefits of the Program

The bumper recycling program was driven first by Ford's commitment to recycling and recycled content for its cars. This commitment is an important part of Ford's environmental strategy and has been emphasized by high-level management.[26] The pull from a major customer, Ford, was sufficient to interest GE Plastics in participating initially. Ultimately, the profit motive was the driver for American Commodities' participation in the program.

Benefits to Ford include:

- Ford is saving money. The recycled Xenoy is cheaper than virgin Xenoy and also cheaper than other virgin resins with similar properties that could be used for the applications in which Ford is using the recycled resin.[27] Recycling of Xenoy resin is economically attractive, because the virgin resin is relatively expensive. American Commodities sells Ford Enviralloy resin for 25 - 30 percent less than virgin prices.[28] Ford estimates that it will save about $1 million per year with the bumper recycling program.[29]
- Ford is demonstrating its commitment to environmental protection and to its recycling goals, which provide corporate image and marketing benefits.[30] A 1993 report by Arthur D. Little, Inc. says that "by the year 2010, 26.7 percent or 57 million potential car buyers will come from the environmentally educated generation." The implication is that tomorrow's car buyers will base their purchase decisions, in part, on just how recyclable that new Ford really is.[31]
- Ford sees its increased recycling as evidence that potentially costly take-back and recycling mandates for cars are unnecessary in the U.S.[32]
- The manufacturing and recycling processes for Ford cars benefit from the reduction in the total numbers of plastic resins used in the car through cascade recycling (reusing higher-quality materials in lower-quality applications).[33]

The bumper recycling program at Ford represents approximately 125,000 bumpers per year that are being diverted from the ASR landfill stream. Additionally, American Commodities is diverting approximately 300,000 more bumpers per year. The use of recycled bumper material replaces the equivalent in virgin resin production, reducing resource and energy use as well as environmental releases during production.

5.3.5 Barriers to the Program

Significant barriers to implementation of the bumper recycling program have been technical, economic, regulatory, liability, and institutional. The primary technical barrier was the difficulty in removing paint and other materials from the plastic material to be recovered. Although paint removal processes have been developed, the use of recycled bumper material is still limited in visible surface applications because of this technical problem.

The economic barriers stem partly from this technical barrier and partly from the lack of an established infrastructure for getting the bumpers from dismantlers to recyclers. The cost of recovering and cleaning up the bumpers ultimately made the program less attractive for the large virgin materials supplier, GE Plastics, which partnered with Ford to initiate the program, than for a small plastics recycler with lower overhead willing to develop the recycling infrastructure with dismantlers. When American Commodities offered a significant price discount for recycled material as compared to virgin, GE Plastics decided to place its participation in the program on hold.

The main regulatory barrier to the bumper recycling program has been the crash worthiness standard that requires extensive testing of recycled material to determine whether it performs as well as virgin material. For this reason, Ford chose initially to utilize 100 percent recycled material in parts that do not absorb crash impacts and to utilize only 25 percent recycled content in parts that are integral to impact absorption. Even with the limited recycled content used in impact-absorbing parts, Ford tested five times as many bumpers to demonstrate compliance with the crash worthiness standard than it would normally test for virgin material. The potential liability associated with supplying a recycled material that is expected to provide a measure of safety for vehicle occupants was also a concern of GE Plastics. GE felt that it would be potentially more difficult to control the quality of the recycled material for this critical application.

Finally, there were the institutional barriers to changes in the status quo that exist in most institutions and barriers to the types of life-cycle partnerships that are necessary for EPR to operate in such a large, diverse industry. Ford designers were concerned about any changes in material quality that might affect the performance of the bumpers. GE Plastics was concerned about handling potentially contaminated scrap in its clean virgin material manufacturing facilities. The success of the program depends upon the willingness of auto dismantlers and recyclers to remove and clean the bumpers in a manner that facilitates recycling while being economically attractive to the dismantler. This partnership between American Commodities and the dismantlers would have been more difficult for larger companies, like GE or Ford, to develop directly.

5.4 SATURN CORPORATION BUMPER TAKE-BACK AND RECYCLING PROGRAM

5.4.1 Extended Product Responsibility at General Motors

The Saturn Corporation is a subsidiary of General Motors (GM) and works under GM's environmental policies and principles. GM has acknowledged Extended Product Responsibility in its corporate Environmental Principles, which include the following:

> *We are committed to reducing waste and pollutants, conserving resources and recycling materials at every stage of the product life cycle.*

GM has also adopted the principles put forward by the Coalition for Environmentally Responsible Economies (C.E.R.E.S.), which is a coalition of investors, public pension trustees, foundations, labor unions, and environmental, religious and public interest groups, which believes that globally sustainable economic activity must be environmentally responsible. Those principals include the following:

We will make every effort to use environmentally safe and sustainable energy sources. We will conserve energy and improve the energy efficiency of our internal operations and of the goods and services we sell.

We will reduce and where possible eliminate the use, manufacture or sale of products and services that cause environmental damage or health or safety hazards. We will inform our customers of the environmental impacts of our products or services and try to correct unsafe use.

GM has also adopted hazardous substances restrictions for materials and products supplied to GM and has developed recycling guidelines used in the design and supplier selection processes. GM also has an innovative relationship with its chemical suppliers where manufacturing facilities enter into "chemical management" contracts in which suppliers receive a fee based upon GM production levels, not based upon volume of chemicals used. Facilities with such contracts in place have realized an average reduction of 30 percent in their chemical usage and up to $750,000 savings per year.[34]

5.4.2 Program Description[35]

Saturn been one of the leaders in developing strategies for greater recycling of plastics used in the automobile. Saturn is one of the first U.S. auto manufacturers to begin a recycling program for post-consumer plastic parts. This program involves a take-back system from Saturn body shops for damaged parts.

Saturn uses TPO (thermoplastic olefins) in the front and rear facia (bumpers) for its automobiles. The facia are painted during the painting of the automobile. While TPO is readily recyclable without paint, painting makes recycling more difficult and results in the recycled material being less suitable for appearance applications like facia and interior trim. Painted plastics can be recycled by blending in with like material for non-appearance applications such as wheel liners.

Saturn began the recycling program with plant scrap, recycling the painted bumper scrap into wheel liners by simply regrinding it and adding it to virgin resin during the injection molding process. In February 1993 Saturn started a pilot program for taking back post-consumer bumpers from body repairs through Saturn retailers. Over a two-month period, 17 participating retailers collected 120 facia, which were recycled with the plant scrap. The post-consumer material showed the same quality as the plant scrap, and the pilot was successfully completed in September 1993.

A full-scale program for collecting bumpers from all of the 340 Saturn retailers was begun in December 1994. First, the retailers collect damaged bumpers from Saturn body shops, which are typically independent companies. The retailers are responsible for establishing this program with the body shops. The body shops transport the damaged bumpers to the retailer when they pick up new parts.

Similarly, when new parts are transported to the Saturn retailers from the Saturn plant in Spring Hill, Tennessee, the trucks pick up the damaged bumpers and return them to the Saturn plant for consolidation. In this manner, there is no extra cost for transporting the bumpers from the retailers to the Saturn plant, because the trucks would have normally returned empty.

Currently, when the parts are returned to the Saturn plant, they are stored in bins and are eventually loaded onto a truck and shipped to a processing facility in Lawrenceburg, Indiana. This shipment is at Saturn expense and constitutes the major expense of the Saturn program. At this point, American Commodities takes ownership of the bumpers. There, any brackets, headlamps, reflectors and bumpers stickers are removed, and the facia are ground before transport to a recycling facility in Flint, Michigan. The American Commodities facility removes the paint and reextrudes and pelletizes the plastics and sells the recycled resins to manufacturers.

5.4.3 Current Status of Program

The Saturn program is currently collecting approximately 15 bumpers per day. Each bumper weighs about nine pounds, so the program represents a diversion of approximately 47,000 pounds per year of plastic from landfill disposal. This quantity of bumpers, however, represents only about ten percent of the new bumpers being shipped to retailers for repairs to Saturn cars. So, there is potential for dramatically increasing the amount of plastics recycled in the program. With 18 pounds of plastic in the front and rear bumpers and over one million Saturns on the road, the eventual diversion from disposal can be very significant.

Currently, the recycled material from American Commodities is not directly incorporated back into new Saturns. Saturn's first priority has been the recycling of plant scrap, and the molding of new wheel wells is now being fed with painted fender scrap from the plant. Saturn has plans to recycle the post-consumer painted bumpers taken back in the Cadillac Division of GM. The bumpers will be ground at or near the Saturn plant, and the ground plastic will be shipped to the molder of wheel wells for the Cadillac plant. This "in-house" recycling will increase the value of the scrap, minimize shipping costs, and provide the benefit of the cost savings within GM.

5.4.4 Drivers For and Benefits of the Program

Saturn is committed to reducing solid waste disposal from all of its operations and has enlisted all of its organization, including Saturn retailers, in the recycling program. The benefits to Saturn of the current bumper recycling program include avoided land disposal costs for Saturn repair shops. Once the bumpers are recycled into wheel wells for new Cadillacs, GM will also benefit from reduced material costs for the production of wheel wells, and Saturn will receive a higher return on the sale of the recycled material.

Product design changes have not been necessary to facilitate facia take back and recycling, because the bumpers are readily removed from the car and are made of an easily recycled material. As Saturn focusses more on post-consumer recycling, however, it expects to facilitate the disassembly of components through necessary design changes and to consolidate materials to reduce materials diversity.

5.4.5 Barriers to the Program

The principal technical barrier for the program, as with the Ford program, has been the removal of paint and contaminants from the scrap bumpers. The economics of the program for Saturn could be improved if the transport costs could be decreased by doing more of the cleaning and grinding of the bumpers near the Saturn plant and could also be improved by reusing the bumper material within GM, as is planned. While Saturn's approach to taking back bumpers from its retailers and repair shops is innovative and efficient, the company has not yet tackled the infrastructure for retrieving bumpers from automobile dismantlers. This institutional barrier may be overcome by the partnership with American Commodities and its dismantler network, but as of yet, there is not a large number of end-of-life Saturns finding their way to dismantlers.

5.5 CONCLUSIONS

Through the bumper recycling programs at Ford and Saturn, the U.S. automobile industry is experimenting with a limited version of take back that was driven by a commitment to recycling automotive plastics but is being sustained by cost savings for the auto companies and profits for the recycling industry. Instead of setting up a whole new infrastructure for taking back and recycling automobiles, the programs rely instead upon the existing service and recycling infrastructure, with the addition of new plastics recycling ventures. At least for relatively large, readily disassembled plastic parts made from relatively expensive engineered plastics, like bumpers, the profit motive has been sufficient to mobilize the existing infrastructure.

These programs represent extended product responsibility because the manufacturers of automobiles have assumed more responsibility for managing materials from end-of-life vehicles. In the case of Ford, the program also demonstrated shared responsibility by the material supplier, GE Plastics. Both Ford and Saturn have partnered with the recycler, American Commodities, with the aim of creating both the supply of and demand for the recycled bumper material. By taking back the bumpers, they have shifted the physical and economic responsibility for managing some of the components of auto shredder residue from the shredders to themselves. Although it is a small step, it begins to improve the economics of metals recovery from the automobile at a time when the percentage of plastics in the car is increasing.

Both programs at this early stage are only recycling a small percentage of end-of-life bumpers available for recycling. The higher amounts of bumpers being recycled in the Ford program are partly indicative of the greater number of end-of-life bumpers available, but also indicative of a program that created a steady demand for the recycled material before collecting it. The automobile industry, with its large demand for plastics, can create the demand for recycled plastics from automobiles that will be necessary to develop and sustain the recycling infrastructure there.

Both the Ford and Saturn programs highlight a conscious technology development strategy of the U.S. automotive industry to leverage programs for recycling plant scrap to ultimately take care of end-of-life plastic parts. Both companies dealt with technology requirements for recycling painted plant scrap before dealing with the more difficult problems of end-of-life parts. Both companies have found out, however, that end-of-life parts are more difficult to recycle, because they often include foreign objects, like bumper stickers, and the properties of the plastics degrade somewhat over time.

The extent to which the two companies created life-cycle partnerships in the bumper recycling programs differed. The Saturn program had no parallel to the Ford/GE Plastics partnership. The fact that GE Plastics is no longer involved in the partnership, however, can be seen as both a success and a failure. The company's extended product responsibility approach succeeded in satisfying the needs of a major customer by demonstrating that its product could be successfully recycled. But the company is now in direct competition with its own recycled product without any direct influence over the manner in which it is recycled or the quality of the material.

Both programs also demonstrate the importance of economics to voluntary EPR initiatives. While attention to end-of-life vehicle recycling in the U.S. is at least partly being driven by the desire to avoid a regulatory approach, it is clear that economics matter to the companies involved. Given the costs of dismantling, sorting, collecting, transporting, and cleaning plastic parts for recycling, it is likely that the economics will only be positive for high-value plastics in large parts that are readily disassembled. The economics are also more positive when the recycled material can directly substitute for a similar high-value virgin material, instead of a lower-value virgin material.

It remains to be seen whether U.S. automotive company recycling efforts that depend upon positive economics throughout the product chain will result in a significant increase in the percentage of materials recovered from end-of-life vehicles. To achieve European targets in the U.S. will require recycling of more plastic parts beyond bumpers or a reliance upon technologies that recover materials or energy directly from ASR. The German voluntary agreement, on the other hand, commits the auto industry to internalizing the costs of increased recycling, even if they are not offset by cost savings of recovered materials or reduced disposal costs.

ENDNOTES

1. For example, BMW estimates that 90 percent of the total energy consumption of a car is from consumer use, 8 percent is from production and 2 percent is from the recycling of materials. Dr. Rudolf Stauber, BMW, October 13, 1992, Landshüt, Germany. Personal Communication to Lori E. Kincaid, University of Tennessee, Center for Clean Products and Clean Technologies.

University of Stüttgart researchers cite figures of 83 percent of total energy use (including 1.5 percent for repairs) during consumer use, 6.9 percent during manufacture, 2.3 percent during assembly, and 7.8 percent by utilization of residual materials. Eyerer, P., T. Dekorsy and M. Schuckert. 1991. "Integral Assessment of Products and Processes." *Kunstoffe German Plastics*. No. 81.

The Environment Ministry of Japan has used life-cycle assessment to estimate that 5 percent of the life cycle energy use of the car is from the vehicle manufacturing process, about 9 percent from materials production, and about 86 percent from the use of the car. Moriguchi, Yuichi, Shimizu Hiroshi and Yoshinori Kondo. 1992. "Analysis and Management of Life Cycle Environmental Impacts of Automobiles - CO_2 Emission Analysis, New Policy on Recycling, and Other Recent Topics." *Cleaner Production Strategies for the Automotive Sector.* Invitational Expert Seminar, Lund University, Sweden, December 11-12, 1991.

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3. Curlee, Randall T., Sujit Das, Colleen G. Rizy and Susan M. Schexnayder. 1994. "Recent Trends in Automobile Recycling: An Energy and Economic Assessment." Prepared by Oak Ridge National Laboratory for U.S. Department of Energy, Office of Environmental Analysis. March.

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CHAPTER 6

INDUSTRY PROGRAM TO COLLECT AND RECYCLE NICKEL-CADMIUM (Ni-Cd) BATTERIES

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6.1 INTRODUCTION

This case study looks at one particular example of extended product responsibility: manufacturers taking responsibility for their products after they are discarded and become waste. The manufacturers of nickel-cadmium batteries (Ni-Cds) and products that contain such batteries have launched a national program to collect and recycle these batteries, at industry expense.

Many battery types can pose serious problems when disposed of as municipal waste; their toxic constituents can be released into the environment from municipal landfills and incinerators, causing damaging health effects. These problems can be ameliorated by reducing the amount and/or toxicity of batteries in the wastestream or by recycling them.

One possible strategy would be to reduce the number of battery-powered products used. This is controversial in an economic system predicated on consumption and growth and is beyond the scope of this report. In fact, the battery industry has worked in recent years to reduce the amount and toxicity of batteries in the wastestream in other ways by: 1) redesigning batteries to reduce or eliminate the toxic constituents; 2) substituting batteries with less toxic constituents; and 3) reducing the number of batteries discarded by extending battery life. Now a major program is being launched to increase recycling. Since batteries are not homogeneous with respect to material composition, design or function, different strategies have been appropriate for the different battery types (described in section 6.2).

As will be discussed in this case study, Ni-Cds cannot be redesigned to eliminate cadmium (the toxic constituent), since cadmium is essential to the battery's function. Batteries with less toxic constituents have been substituted for Ni-Cds but this is not technically possible for all applications. Product life of Ni-Cds has already been extended (as compared to conventional single-use batteries) because they are reusable/rechargeable. The Ni-Cd industry is now opting to address the problem its batteries pose in the wastestream by taking back Ni-Cds and recycling them at industry expense.

Legislation mandating industry take-back or the threat of such legislation has spawned numerous recovery systems for packaging, autos, batteries and electronics around the world, particularly in western Europe. In the U.S., some companies have established programs to take back and recycle or reuse their own products, such as Kodak's take-back program for its single-use cameras. The program now being launched for Ni-Cd batteries is the first nationwide take-back program in the U.S. that involves an entire industry, including many companies, and creation of a separate organization to operate and fund the system.

The mechanisms of such a program are of interest because they address key questions pertinent to take-back systems in general such as: who is responsible? what are the logistics of take-back? and how can such a system be funded? Understanding the system to take back Ni-Cd batteries could be useful in considering how to deal with other problem products in the wastestream. For example, experience with Ni-Cds could be informative for those considering take-back programs for other battery types, fluorescent light bulbs, mercury switches/thermostats, paints and pesticides, and consumer electronic goods and appliances.

6.2 THE PROBLEM OF BATTERIES IN MUNICIPAL SOLID WASTE

6.2.1 Wet Cell Batteries

There are two major categories of batteries: wet cell and dry cell. Most wet cell batteries are lead-acid batteries primarily used for automotive products. About 80 million automotive batteries are sold in the U.S. each year. Discards of these batteries accounted for 1.7 million tons of municipal solid waste (MSW) in 1994. Although less than one percent of the total of 209 million tons of MSW generated, automotive batteries accounted for about two-thirds of the lead in MSW.[1]

Serious concern about the environmental and health impacts of lead spurred EPA to declare lead-acid batteries a hazardous waste in 1985. The majority of states have legislation to remove these batteries from MSW incinerators and landfills — requiring that the batteries either be recycled or disposed of in hazardous waste facilities. Many states have regulations and deposit systems to encourage return of lead-acid batteries. The recycling rate for battery lead in 1993 was estimated at 95 percent, so it has largely been eliminated from MSW incinerators and landfills.[2]

6.2.2 Dry Cell Batteries

Primary and Rechargeable Batteries

The other major category of batteries is dry cell batteries, also known as non-automotive, or consumer batteries. There are two basic types of dry cell batteries — primary and rechargeable. Most dry cells (almost 90 percent in 1992) are primary batteries that must be replaced once discharged. On the other hand, rechargeables can be used repeatedly because the chemical reaction that creates the energy can be reversed, thereby recharging the battery. Rechargeables initially may be more expensive than primary batteries, and require purchase of a recharger, but each rechargeable may substitute for hundreds of primary batteries and cost less than the primary batteries it replaced over its life. About 80 percent of rechargeable batteries are composed of nickel and cadmium and are known as Ni-Cds.[3] A Ni-Cd battery can be recharged hundreds of times.

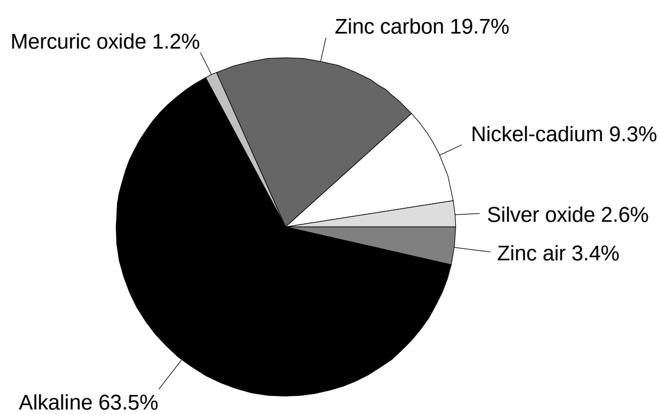
In 1993, Rayovac introduced a new mercury-free, alkaline battery that can be recharged. Unlike most other rechargeables, it is non-toxic. Rayovac is marketing this as a “renewable” battery rather than a rechargeable, mainly because the company does not want it to be categorized with the other rechargeables with toxic constituents. This new battery competes for market share both with primary batteries and rechargeables, but it cannot be recharged as many times as a Ni-Cd.

Markets for Dry Cell Batteries Increasing

Publicly available data on battery sales in the U.S. are very limited. Battery manufacturers are in intense competition for market share and do not release their sales data.

A detailed study of batteries, *Getting a Charge Out of the Wastestream,* estimated that 3.5 billion consumer batteries were sold in the U.S. in 1992 — almost ten percent were Ni-Cds.[4] Figure 6-1 and Table 6-1 show the types of consumer batteries and changes in market share from 1985 to 1992. Table 6-2 shows the types of batteries by units sold and by weight in 1992. Ni-Cd sales in the U.S. were estimated at 326 million units in 1992, or about ten percent of total sales, as shown in Table 6-2. Whereas total consumer battery sales increased about 40 percent between 1985 and 1991, the sales of Ni-Cds increased 60 percent in the same period.[5]

Figure 6-1: 1992 Sales Percentage of Domestic Household Batteries in the U.S.



Source: *Handbook of Solid Waste Management.* McGraw-Hill, p. 9, 151.
Note: Lithium batteries accounted for 0.2 percent of battery sales in 1992.

Table 6-1: Percentage Sales of Domestic Household Batteries in the U.S., 1985-1992

Battery Type	1985	1986	1987	1988	1989	1990	1991	1992
Alkaline	53.48	54.76	57.45	59.26	60.62	61.78	62.72	63.47
Zinc-Carbon	31.73	30.53	27.75	25.73	23.98	22.43	21.01	19.70
Mercuric Oxide	2.58	2.34	2.10	1.85	1.65	1.50	1.37	1.24
Silver Oxide	3.30	3.17	3.00	2.89	2.80	2.73	2.64	2.57
Zinc-Air	0.93	1.07	1.39	1.75	2.03	2.40	2.86	3.38
Sealed Nickel-Cadmium	7.98	8.13	8.30	8.52	8.75	8.97	9.18	9.40
Lithium	N/A	N/A	N/A	N/A	0.17	0.19	0.21	0.23
Totals	100.00	100.00	99.99	100.00	100.00	100.00	99.99	99.99

Source: Hurd, David. 1992. *Getting a Charge Out of the Wastestream*. R2B2, April 17, p. 59.

Table 6-2: Estimated Domestic Household Batteries Sold in the U.S., 1992

Battery Type	Units Sold (millions)	Weight (000s pounds)
Alkaline	2,200	202,712
Zinc-Carbon	683	62,917
Mercuric Oxide	43	149
Silver Oxide	89	180
Zinc-Air	117	402
Sealed Nickel-Cadmium	326	24,057
Lithium	8	490
Total	3,466	290,906

Source: Hurd, David. 1992. *Getting a Charge Out of the Wastestream*. R2B2, April 17, p. 70.

Comparable information on battery sales is not publicly available for 1995, but industry estimates indicate that the market for rechargeable batteries is growing faster than the market for non-rechargeable (primary) batteries.[6] About 80 percent of rechargeable batteries are not sold separately but rather are enclosed in products. The remainder are sold directly to consumers, at retail. According to the National Electrical Manufacturers Association (NEMA), the U.S. retail market for rechargeables is growing twice as fast as the retail market for primary batteries, with compound annual growth of nine percent from 1992 - 1994.[7] The Ni-Cd industry estimates that its batteries had double digit annual growth in the 1980s; this slowed to single digit in the 1990s, but is expected to average over six percent per year.[8]

In general, batteries are becoming much more prevalent due to the dramatic increase in items that require their use, such as battery powered toys and tools, small electrical appliances like toothbrushes and shavers, video cameras, cellular phones, and portable computers. Norm England, President of the Portable Rechargeable Battery Association, says that what is driving the sharp increase in rechargeable batteries is the "consumer's wish to be free of a cord."[9]

Substitution for Ni-Cds

As already noted, about 80 percent of rechargeable batteries are Ni-Cds. Other types of rechargeables in use today are lithium-ion, nickel-metal hydride, small sealed lead-acid, and rechargeable alkaline manganese batteries. None of these battery types are included in the data in Figure 6-1 or Tables 6-1 and 6-2 because these batteries were not available in significant amounts in 1992, or earlier.

Markets for rechargeable batteries cover a broad range of power requirements — from low power drain (portable computers) to high power drain (power tools). At present other rechargeables compete with Ni-Cds for low power drain applications. Ni-Cds have rapidly lost market share to nickel-metal hydride and lithium-ion batteries for use in portable computers.[10] But only Ni-Cds can be used for high power drain applications such as power tools. Ni-Cds continue to dominate the markets for such devices and for other products including electric appliances like "dustbusters," cellular phones, and video cameras.

Batteries Contain Hazardous Materials

Four billion consumer batteries translate to about 15 sold for each man, woman, and child in the U.S. each year. About 146,000 tons of consumer batteries are disposed of each year. These accounted for less than 0.1 percent of MSW in 1992, but they are of concern because they contribute a disproportionate percentage of certain toxic heavy metals, primarily mercury and cadmium, to the wastestream.[11]

In 1989, consumer batteries accounted for 88 percent of the mercury and 54 percent of the cadmium in MSW. Due to the increase in Ni-Cd use, batteries are expected to contribute almost 75 percent of the cadmium in the wastestream by 2000.[12] Discards of cadmium in batteries and appliances nationwide are projected to increase from 1,305 tons in 1990 to 2,032 tons by 2000.[13]

Dramatic progress has been made in the U.S. in redesigning batteries to eliminate mercury content, primarily driven by state mandates.[14] In 1992, the battery industry consumed 98.44 percent less mercury than it did in 1984.[15] This has been possible because most mercury was used in batteries as a gas suppressing additive that could be eliminated by design changes. Further reductions in the use of mercury in batteries will result from *The Mercury Containing and Rechargeable Battery Management Act*, discussed in section 6.3.l.

Cadmium, on the other hand, is used as an electrode material, the power source of the battery. The amount of cadmium in Ni-Cds cannot be reduced because this would cause a proportionate reduction in the energy output of the battery. Cadmium typically accounts for 11 - 15 percent of Ni-Cd battery weight.[16] As discussed earlier, the problem of cadmium in the environment is being addressed by substituting other batteries with less toxic components for Ni-Cds or by assuring that Ni-Cds are recycled and do not enter MSW landfills and incinerators.

The environmental release of cadmium poses potential health threats. Cadmium can accumulate in the environment by leaching into ground water and surface water from landfills, and it can enter the atmosphere through incinerator smokestack emissions. Effective air pollution control equipment at incinerators traps cadmium, which ends up in the ash, causing problems of cadmium in ashfill leachate. Cadmium is toxic to fish and wildlife and can pass to humans through the food chain. It has been associated with numerous human illnesses particularly lung and kidney damage. Once absorbed in the body, cadmium can remain for decades.[17]

Because of the heavy metals they contain, managing batteries as part of the municipal solid wastestream is costly. The costs of diverting batteries can be lower than the back-end costs to the municipal waste system of pollution control devices at incinerators and landfills (such as lime addition at incinerators and double composite liners at landfills). Battery diversion can also decrease costs by reducing the amount of ash from municipal incinerators that must be disposed of as hazardous waste.

6.3 DRY CELL BATTERY REGULATIONS AND LEGISLATION

6.3.1 The Federal Level

Since batteries often contain hazardous or potentially hazardous materials, the regulatory framework is critical to any take-back program. This determines how the materials must be handled and has major impact on the cost of the program.

Hazardous wastes are regulated by the federal government under the Resource Conservation and Recovery Act of 1976 (RCRA): the regulations are codified in Title 40 of the Code of Federal Regulations (40 CFR). RCRA provides an exemption for residential waste. This means that products such as Ni-Cd batteries that are classified as hazardous under federal criteria are exempted if the waste is generated by the residential sector. If a household discards a Ni-Cd battery, it is not subject to hazardous waste regulations. The same battery, if discarded by a business or institution such as a hospital may be subject to these regulations (depending upon the amount of hazardous waste the entity generates). Since consumer batteries are discarded by households, businesses and institutions, different regulations apply to identical batteries, depending on who generates the waste. Costly hazardous waste regulations have presented a major barrier to the take-back of batteries.

In May 1995 the EPA promulgated the Universal Waste Rule (40 CFR Part 273) intended to encourage reclamation and recycling of certain hazardous wastes by removing some of the regulatory barriers. This rule applies to batteries, thermostats, and pesticides. Under the Universal Waste Rule, batteries recovered and properly managed, regardless of who generates the waste, are exempt from some of the stringent provisions of the hazardous waste regulations. This change has helped facilitate the industry take-back system for Ni-Cd batteries but an obstacle remained. In order for the Universal Waste Rule to take effect in a state, the state had to have incorporated it into its own regulations or policy. Thirty-two states had done so as of May 1996.[18]

For five years, the battery industry sought federal legislation to remove regulatory barriers to the collection and recycling of batteries. Such legislation was finally passed by Congress in April 1996 and signed into law by President Clinton on May 13, 1996. *The Mercury Containing and Rechargeable Battery Management Act* (P.L. 104-142) makes the provisions of the Universal Waste Rule applicable nationwide thereby obviating the need for adoption by each state. It eliminates barriers to the take-back system caused by hazardous waste laws. It establishes national uniform labelling requirements for rechargeable batteries. Ni-Cd batteries or products containing them will have to be labelled "Ni-Cd" — "BATTERY MUST BE RECYCLED OR DISPOSED OF PROPERLY." In addition, the law mandates that rechargeables be easily removable from consumer products and restricts the sale of mercury-containing batteries. The labelling and removeability requirements apply to rechargeable batteries deemed toxic such as Ni-Cds and sealed lead-acid batteries. They do not apply to alkaline rechargeables which are not toxic and can be disposed of with regular trash.

Earlier versions of the federal battery legislation mandated that industry take back batteries. The legislation, as finally passed, does not mandate take-back, but rather eliminates barriers to encourage a voluntary system.

The cost implications of the Universal Waste Rule and the subsequent federal battery law are significant as they provide relief from cumbersome RCRA transportation, storage, and paperwork requirements. According to Jeff Bagby of the Rechargeable Battery Recycling Corporation (RBRC), the cost of shipping batteries from Iowa to Pennsylvania, the site of the RBRC recycling facility, was $1 per pound when complying with hazardous waste regulations. Under the new rule, the cost is 17 cents per pound, and it is no longer necessary to fill out hazardous waste manifests and to use hazardous waste transporters.[19] The provisions for standardized national labelling and removeability regulations also have cost savings implications for industry which formerly had to deal with a patchwork of inconsistent legislation in different states.

6.3.2 The State Level

Starting in 1989 when Connecticut passed its battery law, states have taken the lead on dry cell battery legislation: 13 states have passed legislation regulating battery labelling and removeability,[20] and 8 states (CT, FL, IA, ME, MD, MN, NJ, VT) have take-back requirements that apply to Ni-Cds.[21] While many states have mandated separate collection to keep batteries out of MSW facilities, they often do not specify what should be done with the batteries after they are collected. Exceptions to this are Minnesota and New Jersey where the nation's most far-reaching battery legislation has been passed.

Legislation in Minnesota and New Jersey

Stringent provisions on rechargeable batteries became law in Minnesota in 1990 and in New Jersey in 1992. Both states require that rechargeable batteries be easily removable from products, be labelled as to content and proper disposal, and be banned from the municipal wastestream. In addition, they require manufacturers to take rechargeable batteries back at their own expense for recycling or proper disposal.

Legislation in these states distinguishes between batteries that are recyclable, such as Ni-Cds and those that are not, such as alkaline batteries containing mercury. For recyclable batteries, industry takeback is mandated. For the others, content standards are established to reduce the amount of heavy metals.

While the technology was available in the U.S. to recycle Ni-Cds prior to passage of the Minnesota and New Jersey laws, very few were actually recycled. State legislation spurred the development of a recycling infrastructure. The legislation requiring removeability is important since Ni-Cds must be removed from products in order to separate them for recycling. Eighty percent of Ni-Cds are enclosed in cordless tools and appliances, and most were not accessible before the mandate for removeability was implemented.

6.3.3 International

Given the increasingly international complexion of markets and global design of many products, concern in Europe about Ni-Cds and the threat of a ban provided additional incentives to industry to develop a system to recover and recycle Ni-Cds.

Since publication of a report, *Recharging without Cadmium* in 1993, Sweden has pushed for substitution for and even a ban on Ni-Cds. A proposal by the Swedish Ministry for the Environment for a ban on Ni-Cds in all European Union countries is under consideration by the European Union. Sweden also proposed to the Organization for Economic Cooperation and Development (OECD) that Ni-Cds be replaced with nickel-metal hydride batteries — this was voted down. As an alternative, the OECD agreed that industry should work with governments to facilitate Ni-Cd battery collection. This view was included in a formal recommendation to OECD nations.[22] Belgium is targeting batteries with its tax policies: an eco-tax is threatened of 33 cents per battery on types that are not recycled at a rate of 75 percent by 2000.

6.4 THE RECHARGEABLE BATTERY INDUSTRY ORGANIZES FOR TAKE-BACK

6.4.1 The Portable Rechargeable Battery Association (PRBA)

As battery legislation was introduced in states across the nation, the producers of rechargeable batteries broke from the trade associations that had traditionally represented the battery industry — the National Electrical Manufacturers Association (NEMA) and the Battery Products Alliance (BPA). In June 1991, a new trade association — the PRBA was formed by the five largest makers of rechargeable batteries worldwide — Sanyo, Panasonic, Gates Energy Products (now Energizer division of Eveready), Saft, and Varta. While four of these are foreign companies, they all have U.S. operating divisions. PRBA members now include over 100 companies involved in the manufacture, assembly, distribution, use, and sale of rechargeable batteries and products powered by rechargeables.

PRBA has addressed issues of government relations, lobbied at the state and federal levels, and worked to develop a take-back system for rechargeable batteries. PRBA originally proposed, and endorsed throughout, the federal battery legislation adopted in May 1996. This legislation reduces barriers to the battery collection and recycling system and avoids the need to deal with inconsistent legislation in different states.

6.4.2 The Rechargeable Battery Recycling Corporation (RBRC)

In 1995, battery manufacturer members of PRBA set up the RBRC to physically administer the collection and recycling of rechargeable batteries and to license its seal to fund the system. The mission of this non-profit organization is "to perform a public service through the management, collection and recycling of used nickel-cadmium (Ni-Cd) batteries throughout the United States."[23] This includes educating the public on battery recycling, and collecting and recycling batteries for the companies that fund these operations — its licensees.

RBRC has two divisions: 1) the Recycling Division that administers the public education, collection, and recycling programs; and 2) the Finance and Seal Administration Division that licenses and administers the RBRC Seal to raise the funds to finance the system.

Recycling Division

This division works through independent contractors. It provides funding to the PRBA to run its education programs. It also negotiates contracts for the collection, storage, transportation, and recycling of Ni-Cds. The responsibilities of the Recycling Division include assuring compliance with federal and state regulations, collecting and maintaining records that track the batteries, obtaining necessary licenses and permits, obtaining certificates of recycling, and selection and purchase of collection containers.

Finance and Seal Administration Division

This division collects the license fees, monitors compliance with the license agreements, and processes refunds. It administers the Seal and will direct audits by a national accounting firm, as needed.

Insurance

RBRC is providing insurance coverage for its take-back program, which includes coverage for the licensees. The costs of the insurance are built into the fee schedule. Insurance will cover the entire system from collection, through storage, transportation and recycling. Given the potential dangers of handling batteries, such coverage is critical. RBRC is providing $5 million of coverage for storage and recycling facilities and $2 million for transporters. The coverage includes both general liability and contingent pollution liability. [24]

6.5 THE SYSTEM TO TAKE-BACK AND RECYCLE Ni-Cd BATTERIES

RBRC runs the system to collect and recycle Ni-Cds and works with PRBA on the public education campaigns. Unless otherwise noted, all information in this section on the take-back system is from RBRC publications assembled in the document, *Recycling America's Rechargeable Batteries: the Program*.

6.5.1 Funding the Program: Fees and Rebates

The collection and recycling system is funded by license fees paid by rechargeable battery and product manufacturers, which allows them to place the RBRC Seal on their products and packaging. A license fee is paid for each cell within a battery or battery pack that displays the RBRC Seal. Fees are paid by companies based on the weight of batteries put on the market during the previous calendar quarter. The fees are set by RBRC.[25] Typical RBRC fees on Ni-Cd batteries are about 10 cents in a portable computer, 4 to 12 cents in a power tool and 5 cents in a cellular phone.[26] Since this is a voluntary program, companies are free to decide whether to join the program and become licensees.

RBRC Seal

The RBRC budget is negotiated with the largest licensees. Once funds are allocated for the different budget items such as education, collection and recycling and the total is determined, the revenues needed are divided by the amount of batteries placed on the market, to calculate the fees. RBRC is a non-profit corporation, so the fees generated are solely to run the system.

Licensees can apply for rebates on cells not sold in the U.S. market or those exported before final retail sale. They can also apply for partial rebates if they set up their own collection system and ship the batteries directly to an RBRC recycling facility so that double payment is avoided. Appendix A shows the Ni-Cd fee schedule in effect as of July 1996. Appendix B shows the companies that signed license agreements as of July 24, 1996.

6.5.2 Who Is Responsible?

Determining who is responsible for paying the license fees is complicated. Is it the company that manufactured the battery? The company that assembled the battery pack? Or, the company that inserted the battery or battery pack in its product? These functions may be performed by one company or a number of different companies.

Generally, the owner of the brand name on the battery or battery pack is the licensee and the owner of the brand name on the consumer product is a sub-licensee. The situation is simplest when the same brand name appears on both. The licensee pays the fee to RBRC at the end of the calendar quarter in which the batteries are sold into the U.S. market and places the RBRC seal on the battery or battery pack.

RBRC encourages exhibiting the Seal on packaging and mandates that the Seal be on the package if the brand name on the battery pack is the same as the brand name on the consumer product. Use of the Seal in promotional materials by licensees is also encouraged. Success of the RBRC system is dependent upon getting a sufficient number of companies to sign on to the take-back program. Display and promotion of the Seal is encouraged as a way of inducing companies to join the system. The idea is that battery consumers, be they manufacturers of consumer products, individuals or government procurement officers, will prefer products with the Seal, which indicates collection and recycling has been arranged and paid for.

6.5.3 The Collection Systems

To deal with batteries generated by many different sources, RBRC has set up four separate collection systems from: 1) retailers; 2) communities; 3) business and public agencies; and 4) licensees.[27] Batteries from the collection systems are transported to three consolidation points across the U.S.: 1) Wade Environmental Industries, Battery Division, Atco, New Jersey; 2) U.S. Filter Recovery Services, Inc., Roseville, Minnesota; and 3) Kinsbursky Brothers Supply, Inc., Anaheim, California. From these consolidation points the batteries are shipped to the International Metals Reclamation Company (INMETCO) in Ellwood City, Pennsylvania, where they are recycled. Small shipments of batteries (under 150 pounds) are transported by the United Parcel Service (UPS), larger ones by national common carriers.

The Retail Collection System

RBRC and PRBA contact retailers who sell rechargeable batteries and products that contain these batteries to enlist their participation in the program. Brochures and videotapes are used to encourage retailer participation.

Retailers agreeing to participate get Battery Recycling Kits from RBRC free of charge. These kits contain collection containers, a plastic zip-loc bag for each used battery, safety instructions, and signs to place in the store. They also contain a Recycling Manual with details on which batteries are eligible for the program and instructions on the role of the retailers. The retail program was operative in 16 states prior to adoption of the federal battery legislation (in May 1996) and expanded to 35 states within two weeks of adoption.[28]

RBRC is distributing containers with a capacity of about 18 pounds that have passed its safety tests. Larger containers are currently under development. The containers are picked up from the retailers by UPS, and they come with pre-addressed, prepaid shipping labels so that retailers incur no shipping costs. UPS picks up the filled containers and delivers them to the designated consolidation point. At the consolidation points, the batteries are bulked into shipments of 10,000 to 40,000 pounds and sent to INMETCO for recycling by a pyrometallurgical process described later. Records are kept by the consolidation points on the weight of the batteries received and by INMETCO on the amounts received and recycled.

Participating in a battery management program is a new endeavor for retailers. RBRC has made an effort to minimize inconvenience and to avoid any out-of-pocket costs to gain retailer cooperation. All transportation, handling, and recycling charges are paid by RBRC and funded through the Seal fees. The responsibility of retailers is putting the containers in place and mailing them to the consolidation points without charge. Insurance coverage is provided by RBRC. Retail collection initially was only taking place in states that adopted the Universal Waste Rule or made other provisions so that retailers would not be classified as hazardous waste handlers. Following the passage of the federal battery law in May 1996, nationwide implementation of the retail collection system began.

An incentive for retailers to cooperate with the program is the service provided by the toll-free telephone number 1 800-8-BATTERY, operated by RBRC. Consumers can call this number to find out what to do with their used batteries. They are given the name of the nearest retailer who will take back Ni-Cds for recycling, which can lead to increased sales for that retailer. Counties and municipalities also publish the names of the retailers participating in the program — another marketing advantage for the retailers.

The Community Collection System

The goals of the collection system are two-fold. The first goal is to get Ni-Cds out of the municipal solid wastestream and send them to recyclers rather than municipal incinerators or landfills; the second goal is to utilize the solid waste collection infrastructure already in place in counties and municipalities to do this. This infrastructure may include curbside collection programs, household hazardous waste collection sites and events, or recycling centers.

Under the RBRC program, the community can use its existing collection system. It then brings the Ni-Cd batteries to one central location where they are consolidated and shipped to one of RBRC's three consolidation points and then on to the recycler. The community must transport the batteries to the central location in the county but RBRC pays all the subsequent shipping costs. The community registers with one of RBRC's consolidation points and calls when a pick-up is needed. Pick-ups will not be more frequent than once per month and are supposed to weigh at least 1,000 pounds.

This collection system requires very large containers. Most communities currently use 55-gallon steel drums. The RBRC program will continue to use these drums and RBRC will pay the drum disposal fees.

Like the system for retailers, RBRC will provide materials to encourage participation as well as a Recycling Manual. Records will be kept of the weight of batteries shipped and recycled.

The RBRC program may impose additional costs on communities, even if they currently have separate battery collection programs, but it also provides benefits. The added costs are due to the need to separate Ni-Cd batteries from the other consumer batteries collected, since RBRC only takes back Ni-Cds. The benefits derive from reduced shipping, recycling and/or disposal costs for used batteries. Such fees can be high.

For example, Putnam County in New York State pays about $10,000 to a contractor to take all the materials (including batteries) that it collects on its annual household hazardous waste collection day. About five tons are collected, so managing this waste costs about $2,000 per ton. The county could send Ni-Cds directly to a battery recycler, but it would have to pay the recycler $1,600 per ton to take the Ni-Cds, and in addition, would have to pay for sorting and transportation.[29] Under the RBRC program, private industry pays the shipping and recycling costs for Ni-Cds, thereby reducing the financial burdens on the counties and municipalities.

For communities that do not currently have separate consumer battery collection, the costs of the RBRC program are greater as they must set up a separate battery collection system and consolidate the batteries at one point. The benefits of doing this would be reduced pollution from incinerators and landfills. A less toxic municipal wastestream should lead to reduced disposal costs as well as improved public health.

The Business and Public Agency Collection System

The business and public agency collection system is aimed at businesses, government agencies and institutions, ranging from auto factories to hospitals and police departments. Most of these generators are currently prohibited from disposing of Ni-Cds in MSW so they generally have programs to send the batteries to recycling or proper disposal facilities. The goal of RBRC's program is to get more of the batteries diverted to recycling rather than disposal, to reduce the incentives for illegal disposal, and to encourage those without a battery management program to become part of one.

Under this program, the entity collects its own Ni-Cds in its own containers and pays to ship them to one of the three RBRC consolidation points. RBRC pays all additional costs of the system, including the container disposal fees. The containers used must meet RBRC specifications. The generator can arrange the shipping or request the consolidation point to arrange it, but in either case the generator pays the shipping costs. UPS handles the shipments under 150 pounds. Common carriers handle the larger shipments that are arranged by the consolidation points.

The rest of the program is the same as the systems for retailers and communities. RBRC provides educational materials, a Recycling Manual, and documents the amount of batteries shipped and recycled.

Many business and public generators already have battery management programs. If they separately collect Ni-Cds, the RBRC program should not impose additional costs. If they do not, they will incur the costs of separating Ni-Cds. Without the RBRC program, these generators must pay the full costs of collection, transportation, and recycling or disposal. Under the RBRC program, they only pay for getting the batteries to the consolidation points. Again there is a shift in responsibility — under the RBRC program, much of the cost of battery management is shifted from the generators of the waste to the manufacturers of the batteries or battery-containing products.

The Licensee Collection System

The goal of the licensee collection system is to encourage companies that are RBRC licensees to develop their own collection system. They are uniquely able to collect batteries from their customers through reverse distribution programs and also from their own service centers or retail outlets. All of this is optional, however: they can be licensees and choose to have their batteries collected under the other three collection systems.

Under the RBRC licensee collection system, the manufacturer collects its own batteries. It pays to ship them in its own containers directly to the recycler. RBRC pays the recycling charges and drum disposal fees. The manufacturer is eligible for a rebate of about 75 percent of the Seal license fees it has already paid. The rebate is currently $0.1746 per pound.[30] In other words, the manufacturer pays the Seal fees when it puts the batteries on the market. If it takes back its own batteries and sends them to the recycler, it gets a rebate on the fees already paid. This is to avoid paying twice.

There are two separate issues for a manufacturer of Ni-Cds or products containing Ni-Cds: 1) whether to become an RBRC licensee; and 2) whether to establish its own take-back system for its Ni-Cds. There can be distinct marketing advantages in being a licensee — a product with hazardous materials that might be outlawed has its collection and recycling arranged and paid for. With respect to take-back, the rebate system enables manufacturers to develop their own Ni-Cd collection systems that they can fund with the rebates received. A company can be a licensee and not have its own take-back program. In that case, the licensee is paying to have the batteries collected from retailers, communities, businesses, and public agencies.

Companies that are not RBRC licensees, such as some computer manufacturers (discussed in section 6.6.3), do not pay the RBRC fees initially and therefore do not get rebates. Their take-back systems are totally apart from the system run by RBRC. They create such systems because their Ni-Cds cannot be sold in some states, such as New Jersey and Minnesota unless the manufacturers take them back for recycling or proper disposal.

6.5.4 The Recycling System

RBRC has chosen to recycle all of the Ni-Cds it collects. This is not mandated by any state or by the federal government — proper disposal of the batteries as a hazardous waste is permitted. RBRC sends all of the Ni-Cds it collects to International Metals Reclamation Company (INMETCO), a recycler in Pennsylvania, under a five year contract effective January 1, 1995. INMETCO is a subsidiary of The International Nickel Company (INCO) of Toronto. INMETCO was established in 1978 to recycle wastes from stainless steel manufacturing and is located near many of the specialty steel mills in the U.S. It is the only recycler in North America with the high-temperature process necessary to reclaim all raw materials from Ni-Cds — the technology that the EPA has determined to be BDAT (best demonstrated available technology).[31]

INMETCO's process involves draining the batteries, shredding them, and feeding them into a 2300 degree (F) furnace. In the past, nickel, and iron were recovered and used in stainless steel production for products such as sinks, but the cadmium was sent elsewhere for recycling or proper disposal.

Under the RBRC contract, INMETCO had to expand to provide adequate cadmium smelting capacity by the end of 1995. In December 1995, INMETCO announced the installation of its new $5 million cadmium recovery plant. The cadmium, 99.95 percent pure after recovery, will be used in the manufacture of new Ni-Cd batteries.[32] The cost of the cadmium recycling is already built into the RBRC fee schedule. Under this system, RBRC can legitimately claim it has arranged for the collection and recycling of Ni-Cd batteries as only process waste will go to disposal.

6.6 STATUS OF THE RBRC PROGRAM TO RECOVER Ni-Cd BATTERIES

6.6.1 The RBRC Program Goes Nationwide

The federal battery legislation signed into law on May 13, 1996 had immediate impact on RBRC's program to collect and recycle Ni-Cd batteries. Previously, the program had been launched on a state-by-state basis contingent on state adoption of the Universal Waste Rule. After passage of the federal legislation, the strategy was changed to a focus on sectors nationwide.

In June 1996, major retailers across the country were targeted to join the program. According to RBRC, retailers began asking for collection bins following passage of the federal battery law. For example, Radio Shack, which had been participating in the state programs, requested bins for its 6,800 stores nationwide.[33] Major retailers such as Sears, Walmart and Best Buy and telephone retailers like Cellular One, Bell Atlantic, Pacific Bell, Bell South, and Ameritech were asked to participate in the retail collection system. Prior to passage of the federal legislation, there were retail bins in 16 states. In the two weeks following passage, this was extended to 35 states. RBRC reports retailers want to be pro-active on the environment and are enthusiastic about joining the system.[34]

The second group targeted, in July 1996, consists of public agencies (police, fire, schools and hospitals) that can participate in the business and public agency collection program. Targeted third, in August 1996, were recycling coordinators across the country who could launch the community collection system.[35]

On May 21, 1996, shortly after President Clinton signed the federal battery legislation into law, RBRC held a press conference to launch its multi-million dollar nationwide battery recycling campaign called "Charge Up to Recycle!", aimed at the general public. Richard Karn, star of the T.V. show "Home Improvement," is RBRC's celebrity spokesperson for the program. He will make personal appearances across the country as well as appear in RBRC public service announcements for TV, radio, and the print media.[36]

6.6.2 Earlier Education/Outreach Campaigns

In 1994 RBRC launched its education program and began recruiting licensees. The effective date for the License Agreement, use of the Seal, and the contract with INMETCO was January 1, 1995.

The telephone number 1-800-8-BATTERY was established in March 1995 to enable consumers to call and get information on where and how to recycle Ni-Cds. At the end of 1995, approximately 4,500 retailers and 300 county/municipal recycling locations were on the system.[37]

Later in 1995, a fax-back system was launched. The purpose was to make available current information on state battery legislation and regulations, and also specifics of the logistics of the RBRC system. Following adoption of federal legislation, the fax-back system was revised to focus on the four collection systems nationwide. There is a unique fax-back phone number for each of the collection systems. The information is tailored to the type of collection program served. For example, businesses and public agencies or communities can use this system to obtain information on collection locations, regulations/legislation, specifics on how to collect, store and ship Ni-Cds, employee training, and current licensees. Fax-back can also be used by retailers to order replacement collection supplies.

6.6.3 Signing Up Licensees

A critical hurdle in establishing the take-back system for Ni-Cd batteries was getting a substantial number of companies to agree to be licensees. Without this, the voluntary system could not work. This hurdle has been cleared: according to RBRC "by the end of 1995, over 170 companies representing over 75 percent of the Ni-Cd batteries sold into the U.S. market had signed as RBRC Seal Licensees."[38] All of the major Ni-Cd producers have joined the program. Some cellular telephone manufacturers had not become licensees as of May 1996 but are expected to join the system in the future.[39]

A number of computer manufacturers such as such as Compaq, Digital Equipment, and IBM have not become licensees. As noted earlier, some computer companies are phasing out the use of Ni-Cd batteries in their products and replacing them with nickel-metal hydride or lithium ion batteries; some have their own battery take-back programs. Other computer manufacturers such as Tandy, NEC, and Toshiba are RBRC licensees.

Compaq, for example, has chosen to operate its own battery take-back program rather than join the one run by RBRC. Compaq believes all rechargeable batteries should be collected and recycled and objects to RBRC taking back Ni-Cds only. Compaq believes its program is "more user friendly" than RBRC's and does not anticipate significant numbers of Compaq batteries entering the RBRC program. Compaq says that, on occasion, RBRC batteries enter its recycling program, and that it has recycled these batteries without charge to RBRC.[40]

6.6.4 Battery Recovery and Expansion Plans

RBRC says it recovered 15 percent of discarded Ni-Cd batteries nationwide in 1995. These primarily came from the commercial sector, with less than 25 percent from households. RBRC's goal is to collect 70 percent by 2001.[41]

Table 6-3 shows the RBRC estimates of the amounts of Ni-Cds sold, discarded, and recycled. These data are for batteries processed through the RBRC program and do not include batteries shipped overseas for recycling or those disposed of in hazardous waste landfills.[42]

Table 6-3: Ni-Cd Recycling Rates in the U.S.
(thousands of pounds of batteries)

Year	Sales	Discards	Recycled	Rate
1993	30,027	14,221	284	2%
1994	31,865	15,760	630	4%
1995	33,757	17,921	2,703	15%
1996	35,710	20,523	5,131	25%
2001	46,540	37,522	26,265	70%

Source: RBRC.

RBRC expanded its program into Canada as of January 1997. Expansion into other countries is under consideration, with Australia and Mexico heading the list. RBRC also is considering expanding its program to collect other battery types, beginning with pilots to collect nickel-metal hydride batteries in the U.S.[43]

6.6.5 Battery Recycling

INMETCO can recycle 3,000 tons of spent batteries per year. Its facility is designed to expand to 10,000 tons once national battery collection programs are fully operative. Ni-Cd recycling at INMETCO increased from 50 tons per year in 1989 to 1,200 tons in 1992. INMETCO estimates it recycled 2,500 tons of Ni-Cds in 1995 from RBRC and other sources.[44]

In addition to Ni-Cds, INMETCO recycles other battery types such as nickel-iron, nickel-metal hydride, and zinc carbon. It has considered licensing its technology abroad. In 1996, INMETCO was the only recycler of Ni-Cds in the U.S. — other facilities are located in France and Sweden.

6.6.6 Costs of the RBRC Program

Questions often raised about take-back programs are: what is the cost? and will this increase the price of the product? RBRC estimates that its costs of $5.5 million are one percent of Ni-Cd sales prices. (Table 6-4 shows the breakdown of RBRC's estimated 1996 costs.) The percentage is an average and can vary with Ni-Cd size and configuration.[45] In fact, RBRC expects to recycle 5,131,000 pounds of batteries in 1996, or about 2,500 tons. At a total cost of

$5.5 million, this is about $2,000 per ton — very similar to the current costs to communities of disposing of hazardous waste, as described in section 6.5.3.

Table 6-4: Estimated RBRC Costs for 1996

	$ (millions)	%
Administrative	.8	15
Public Education, Collection, and Recycling	4.7	85
Total	5.5	100

Source: RBRC, fax, June 13, 1996.

The RBRC costs are paid by manufacturers of Ni-Cds and products that contain Ni-Cds. If the increase is passed on to consumers, it could amount to a one percent price increase for the battery. Since an overwhelming proportion of Ni-Cds are contained within products, the price increase would be far smaller than one percent for the product. This is not necessarily a net increase in costs to society but rather a shift in costs. Shifting the costs of collection and recycling to manufacturers may decrease the costs local government must pay to manage batteries disposed of by households. This includes the direct costs of collecting, recycling and disposing as well as costs of pollution prevention equipment at disposal facilities. So internalizing the costs into battery prices means that consumers may pay higher prices for batteries but lower municipal taxes.

There is a different scenario for the batteries RBRC collects from the commercial sector. Commercial users typically pay to manage their battery waste. The RBRC program reduces the costs these companies would pay at the end of battery life and shifts them to manufacturers who may internalize the costs into the price of the batteries. Commercial users still pay but in a different way — they are likely to pay the collection and recycling costs for Ni-Cds when they purchase the batteries, not when they dispose of them.

6.6.7 State Pilot Programs

Prior to adoption of federal battery legislation in May 1996, RBRC was introducing its program on a state-by-state basis. In 1995, RBRC took over existing Ni-Cd recycling programs from PRBA in Minnesota and New Jersey.

Minnesota Program

Minnesota legislation requires that manufacturers establish a program to recover 90 percent of Ni-Cd and small sealed lead-acid (SSLA) rechargeable batteries, statewide, beginning September 20, 1995. Prior to that date only pilot projects were required. PRBA began a pilot program to take back rechargeable batteries in Minnesota at the end of 1992. Responsibility for the take-back of Ni-Cds was transferred to RBRC in 1995, with PRBA still responsible for the SSLAs.

Data on battery collection is fragmentary at this time, due in part to the transfer of responsibility from PRBA to RBRC and also to the fact that the program is relatively new. According to a report of October 1, 1995, submitted by PRBA in conjunction with RBRC (PRBA/RBRC report), these two organizations collected approximately 91,793 pounds of used

Ni-Cds and SSLAs in Minnesota from October 1, 1994 through September 20, 1995.[46] The report does not provide separate data for each battery type, leading Minnesota officials to question whether most of these are Ni-Cds.[47] Inclusion of batteries collected by PRBA prior to October 1, 1994, brings the total collected in Minnesota to 232,190 pounds since the program's inception in 1992.[48]

U.S. Filter Recovery Services, Inc., the consolidation point in Minnesota, has a contract with RBRC to sort batteries by chemistry and ship them to appropriate recyclers. U.S. Filter reports receiving 80,984 pounds of Ni-Cds between October 1994 and September 1995. Retail stores sent 3,040 pounds; 15,277 pounds came from counties; and the remaining 62,667 pounds came from businesses and public agencies. U.S. Filter reports contamination has not been a major problem: if some other battery types are found in the Ni-Cd bins, U.S. Filter sorts them out and sends them to appropriate recyclers or back to the generators.[49]

Retail collection of Ni-Cds in Minnesota was based on the system described in section 6.5.3 — with free battery collection boxes and shipping by UPS funded by RBRC. In 1995, about 300 retailers were participating in the Minnesota program — mostly Radio Shack and hardware stores.

According to the Minnesota Pollution Control Agency (MPCA), retail collection of used batteries is more promising than community collections. Retailers are more accessible to consumers than county drop-off points or household hazardous waste collection sites. The program will eventually include the large retailers like Target, Walmart, and Kmart. Minnesota county officials are telling people to bring batteries back to the retailers. So far, contamination has not been a big problem in the retail program — people have understood the difference between Ni-Cds and other batteries and are depositing them correctly.[50]

It is too early to judge the effectiveness of the battery take-back program in Minnesota but, according to PRBA, removeability has been accomplished — "Most PRBA member companies have redesigned their rechargeable products so that the batteries can be easily removed, and substantially all covered products now meet this requirement."[51]

Since the mandate (as of September 20, 1995) is for 90 percent recovery, the MPCA is developing a measurement methodology to estimate battery recovery rates so it can determine progress toward meeting the goal. This will put far more pressure on PRBA and RBRC which up to now just had to demonstrate they had some operative pilot projects. The MPCA says the Ni-Cd program is impressive and aggressive but the SSLA program is disappointing.[52]

The New Jersey Program

Like Minnesota, New Jersey also has legislation (adopted in 1992) that requires manufacturers to take responsibility for used rechargeable batteries and either recycle or dispose of them in an environmentally sound manner. In New Jersey, where Ni-Cd collection started in May 1993, the Department of Environmental Protection (DEP) estimates a recovery rate of about 10 to 12 percent.[53]

New Jersey law requires that battery recovery rates be reported to the New Jersey DEP every six months. PRBA and RBRC filed a joint report on results of the rechargeable battery program in New Jersey for the first six months of 1995. RBRC filed the report alone for the second half of 1995, because it had assumed full responsibility for the program. Table 6-5 is based on data from these reports unless otherwise noted.[54]

Table 6-5: Collection (in pounds) of Ni-Cd Batteries in New Jersey, 1995

Collection System	1st Half	2nd Half	Total 1995
Retail	1,858	1,598	3,456
Business & Public Agency (including licensees)	16,166	26,592	42,758
Community	NA	436	436
Total	18,024	28,626	46,650

Source: PRBA/RBRC and RBRC reports to New Jersey DEP.[55]

As shown in Table 6-5, the collection of Ni-Cds in New Jersey during the second half of 1995 represented an increase of over 60 percent from the first half of 1995. This was all accounted for by the commercial sector. Separate community collection data were not available for the first half of 1995.[56] The New Jersey DEP notes that despite initial enthusiasm for the program, retailers tend to drop out unless the education program is sustained.[57] The national publicity campaign, noted in section 6.6.1, was designed to focus attention on retailers.

New Jersey depends heavily on incineration (for 30 percent of its waste) and is focussed on getting heavy metals out of its wastestream for both economic and environmental reasons. The New Jersey DEP estimates that it costs $17 million a year to control cadmium, lead, and mercury (from discarded products) in municipal incinerators.[58] In addition, the costs of landfilling incinerator ash are about $30 to $45 million per year because of heavy metal concentrations. The New Jersey DEP concludes that counties with municipal waste incinerators could save $40 to $60 per household per year with programs focussed on getting products with heavy metals out of the municipal wastestream.[59]

6.6.8 Experience with Retailers

Radio Shack says the RBRC program for Ni-Cd batteries has been well received in both Minnesota and New Jersey. Radio Shack reports having bins in its stores (as of January 1996) in those states and also in Connecticut, Florida, Iowa, Massachusetts, Michigan, North Dakota, New Hampshire, New York, South Dakota, and Vermont. According to Radio Shack, all of its stores do not have bins in all of these states and "the amounts collected are not known." Radio Shack plans to adopt the Ni-Cd collection program nationwide.[60]

Radio Shack notes that participating retailers have the benefit of RBRC promotion including their business being identified when customers in their area call the toll free RBRC number for recycling information. Company officials confirm RBRC's assertion that there is no cost of participation for retailers and no need to generate shipping documents or maintain elaborate records. Contamination (consumers putting other battery types in the Nid-Cd bins) has not been a problem.[61]

6.7 LESSONS FROM THE RBRC EXPERIENCE

6.7.1 Collection/Recycling Results

The RBRC system is very new, and it is not yet known whether it will recover a substantial portion of discarded Ni-Cd batteries. While no national target has been legislated, RBRC's goal of recovering 70 percent by 2001 is an ambitious one and, if met, will be a significant achievement. The reported increase in recycling of Ni-Cds from 2 percent in 1993 to 15 percent in 1995 is impressive. A thorough and complex system is being put in place, but an outstanding question is to what extent will battery users cooperate?

Industry cooperation is already evident since RBRC claims 75 percent of Ni-Cds now being sold are under license and bear the RBRC Seal. An exception are certain computer manufacturers who either have or expect to phase out the use of Ni-Cds in their products.

A major education campaign will be required to get consumer cooperation in placing Ni-Cds in the proper bins at retailers or community collection sites. Many consumers may not understand the importance of separating Ni-Cd batteries even though the federal battery law requires a clear label stating the batteries must be recycled or disposed of properly. As of 1995 or even earlier, most Ni-Cds carried an identifying label in accordance with state laws, so consumers should be able to distinguish them from other battery types even before the federal law takes effect.[62]

It will still remain easy for consumers to throw their Ni-Cds in their regular garbage pails and there is no financial incentive for them to do otherwise. Even if Ni-Cds are banned from the wastestream by states or localities, how will this be enforced? Success of the program will depend on extensive consumer education and commitment of individuals to manage waste batteries properly as well as easily accessible and identifiable drop-off locations. If this voluntary approach does not work, deposits could be mandated for Ni-Cds by some states to provide consumers with an incentive to bring them back. RBRC is counting on consumer support for recycling and says that consumers have separated items such as newspapers and bottles and will be willing to do the same for batteries.[63]

Sweden's experience with Ni-Cds gives cause for concern. To avoid take-back legislation, the battery industry in 1993 concluded a voluntary agreement with the Swedish government to collect 90 percent of Ni-Cds by the summer of 1995. Industry only achieved a collection rate of 35 percent. The Swedish environment ministry is now seeking a ban on Ni-Cds.[64]

Recycling developments in the U.S. have been positive so far. The amount of Ni-Cds recycled has been steadily increasing. The RBRC program led INMETCO to invest in a new cadmium recycling facility. The cadmium recycling is "closed-loop" — the type of system long advocated by environmentalists — with the cadmium recovered being used to make new Ni-Cd batteries. INMETCO's new cadmium facility demonstrates that manufacturers taking responsibility for their products after they become waste can stimulate the development of new recycling capacity.

6.7.2 Measuring Results

The data on Ni-Cd collection and recycling are limited at this time. This is understandable since the program is new and responsibility for it has recently been transferred to RBRC.

There will be no way to evaluate the program in the future unless more complete data are available. The consolidators and the recycler are required to keep track of the batteries they handle. The program is dealing with a homogeneous wastestream and four collection systems. In the future, it should not be difficult to document the amount of batteries collected and recycled, by collection system. Hopefully this can be done on a state and a national basis. Such information can be very helpful in identifying the parts of the program that are working well and those that need improvement.

6.7.3 Federal Regulatory/Legislative Support

Some interesting lessons have already been learned from the RBRC experience. One relates to impediments to such a system. Implementation of the RBRC program was contingent on adoption of the Universal Waste Rule which relieved participants in the system of the burdens and costs of complying with hazardous waste regulations. This took five years and delayed implementation of the system. Failure to pass this rule could have permanently doomed the RBRC system. Even after adoption of the Universal Waste Rule, the program was hampered by the need to get adoption by each state — a slow and cumbersome process. Passage of the federal battery law is a major step forward in encouraging industry to extend responsibility for its products. Similar legislation may be needed in order for take-back systems to be implemented for other products potentially subject to hazardous waste regulations since the federal battery law applies solely to batteries.

Shifting responsibility for products at the end of their life to private industry involves issues of liability and compliance. There are also possible anti-trust concerns with respect to take-back systems dependent on competing companies working together to set fees. Government can encourage industry to voluntarily take more responsibility for its products by enacting regulations that are necessary to facilitate such programs or by removing regulatory barriers as it did in the Universal Waste Rule.

6.7.4 Role of States

Battery legislation in states such as New Jersey and Minnesota was a driving force behind the RBRC program. In the absence of federal legislation, states can play a major role in spurring industry initiatives to extend responsibility for products. It is far more efficient to have a single national program to collect and recycle Ni-Cds rather than different requirements and programs in different states. But without legislation at the state level, it is doubtful that a national program to recycle Ni-Cds would have been implemented. Conflicting state laws on labelling and mandatory collection actually led the battery industry to encourage federal legislation. States are in a strategic position to stimulate industry to extend responsibility for products, either through state legislation or cooperative, voluntary agreements with industry.

Many "voluntary" EPR initiatives in the U.S. and abroad have been created to pre-empt anticipated legislation. The RBRC take-back system enabled industry to comply with the mandatory take-back requirements already legislated in some states and to pre-empt legislation in other states.

6.7.5 Value of Green Marketing

Green marketing was another factor that motivated manufacturers to take back and recycle Ni-Cds. The environmental impact of batteries has been of concern to government and to consumers. Rechargeable batteries have been promoted as "green" products because of their reusability (rechargeability). Since each one can replace hundreds of non-rechargeable batteries, rechargeables clearly can reduce the amount of batteries entering the wastestream. The problem is that cadmium is a hazardous material. If industry takes back the batteries and recycles them, it can mitigate the problems Ni-Cds can cause if they are in the municipal wastestream and discourage efforts by governments to ban them. While rechargeable batteries may be "green" in comparison with single use batteries, the claim needs to be reevaluated when they are used in products as an alternative to manual or electrical power.

Recycling is a marketing tool with respect to retaining current market share and acquiring market share in new industries. For example, there is intense research taking place on fuel cell and battery technologies for electric vehicles. Ni-Cds are in contention in this emerging market. If batteries are to be used in electric vehicles, the availability of recycling technology will be a factor in determining what type of batteries are chosen. This will be true for other battery markets as well.

6.7.6 Avoiding "Free Riders"

Voluntary systems frequently have a "free rider" problem. This occurs when companies benefit from the program but do not pay the fees. This has been a major problem in implementing the "green dot" system for packaging in Germany.[65] RBRC has said it would take back all Ni-Cd batteries even if they do not carry its Seal. This means a company can have its batteries recovered by RBRC but not pay for the program.

So far, 75 percent of the batteries being put on the market in 1996 have the Seal. It will be important to maintain a high licensee participation rate. It will also be important to enforce the fee system. In Germany, shortly after the "green dot" program was implemented, 90 percent of the packages had a green dot but fees had only been paid for 60 percent. Companies were printing the dot without paying the fees, or underestimating the amount of fees owed.[66] RBRC may have less of a problem since it is dealing with under 200 licensees, but it will need an effective enforcement system to assure proper payment of the fees. Non-licensee computer manufacturers are possible "free riders" on the RBRC system. Even if they have their own take-back systems, their batteries may end up in the RBRC bins. This will become less of an issue in the future as Ni-Cd use in computers is phased out.

One way to address the "free rider" problem is for states to enforce their legislation. As noted in section 6.3.2, the sale of Ni-Cd batteries are banned in many states unless the manufacturers take them back and either recycle or properly dispose of them. Strict enforcement of such provisions would encourage all manufacturers selling Ni-Cds in these states to either become RBRC licensees or to set up their own take-back programs.

Government (federal, state, and local) can also provide encouragement by using procurement guidelines to support industry efforts. If government would buy rechargeable batteries or products containing them that are part of a take-back program, companies would have a greater incentive to become and to remain licensees. This would be true of any product take-back system funded by the licensing of a trademark.

The Netherlands has developed a policy to deal with the "free rider" problem. The Dutch national waste law provides that a substantial number of companies in an industry can request national legislation. If a majority of companies in an industry sign a voluntary agreement with the government to meet environmental objectives, these companies can request that the government pass a law making the program mandatory for all companies in that industry. So far this has not been invoked, but it is a backup tool that could be invoked if "free riders" become a problem.

6.7.7 Definitions/Classifications and Terminology

Another lesson from the RBRC experience is the importance of definitions/classifications and terminology. For example, retailers are willing to participate in the take-back of Ni-Cd batteries only if the batteries are not considered a hazardous waste. The classification affects costs of the system and also liability.

Companies are also more willing to institute take-back systems if the items taken back are defined as "products" not as "waste." According to the New Jersey DEP, lawyers advise companies not to become waste managers. If the company is taking back a "product" it does not have to deal with all the permits and regulations that apply when taking back "waste." When Panasonic expressed interest in taking back computers and demanufacturing them, the New Jersey DEP responded that if the company takes responsibility, DEP would not regulate the computers as "waste" and would instead consider them "products."[67] Companies prefer to take back products and to call the program "asset recovery." Shifting responsibility for waste may be accurate terminology but new programs are more likely to be implemented if they are called "asset recovery." This is not just an issue of semantics — there are substantive consequences to the terminology used.

6.8 CONCLUSIONS

Other companies or industries interested in establishing a collection and recycling system for their products will have much to learn from the RBRC experience. The program described in this case study may emerge as a model in the U.S. for take-back programs that involve many companies and are handled by a third party.

The structure of RBRC and its licensing system could be adapted to other industries. In multi-company take-back systems, license fees can provide a method of allocating financial responsibility when it is not feasible for each company to take-back only its own products. The licensing arrangements provide a mechanism for allocating the costs across many companies in an equitable and efficient manner.

Take-back programs require the development of new logistical systems. The collection system for Ni-Cd batteries described in this report is one such system. Obviously systems will be different for different products — taking back batteries is different from taking back automobiles or computers. A major distinction is whether companies take back only their own products or whether a third party takes back products for a large number of producers. In addition to providing information about third-party systems generally, the RBRC experience will indicate the level of cooperation that might be expected from households, institutions, and the commercial sector.

The RBRC system represents a shift in responsibility for used batteries, from municipal government to private industry. This focusses company attention on the end of life of batteries and internalizes the costs of collecting and recycling used batteries into the price of the product. If these costs are excessive, the companies have an incentive to develop alternative batteries with lower collection and recycling costs or less environmental impact. The technology challenge rests with private industry, which is much better able to address it than municipal government. The assumption of this responsibility by industry is likely to drive innovation in battery design, recycling technologies, and collection systems; to lessen adverse environmental impacts of batteries; and to provide industry with new marketing opportunities.

RBRC is already considering expanding its system to additional rechargeable battery types and to other countries. Pilots to take back nickel-metal hydride batteries will be conducted in the U.S. in late 1996. As noted earlier, RBRC will expand its system into Canada in 1997 and is considering operating programs in Australia and Mexico. Take-back systems are far more advanced in many other countries, particularly in Europe, than in the U.S. but they have not been developed specifically for Ni-Cd batteries. The RBRC program gives U.S. industry an opportunity to provide international leadership in this specific application of extended product responsibility.

The RBRC effort to collect and recycle Ni-Cd batteries is an important one. It is the first multi-company attempt on such a large scale in the U.S. Success will be contingent upon meeting the ambitious targets set by the producers of Ni-Cds. If the program is successful, it can help in the future marketing of Ni-Cds, reduce costs of MSW management, reduce environmental impacts and increase the efficiency of material use. The nickel and cadmium recovered in this program will have a new life in new Ni-Cds and stainless steel products rather than requiring disposal in incinerators and landfills.

ENDNOTES

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66. Industry is mandated to take back packaging waste in Germany and funds the program by licensing a logo — the "green dot," which is printed on the packages. For information on the program see: Bette K. Fishbein. 1994. *Germany, Garbage and the Green Dot: Challenging the Throwaway Society.* INFORM, Inc.

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CHAPTER 7

PRODUCT STEWARDSHIP AT XEROX CORPORATION

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"There are good reasons to protect the Earth...it's the safest and surest way to long-term profitability."

Paul Allaire, Chairman and CEO, Xerox Corporation[1]

7.1 INTRODUCTION

The Xerox Corporation sells publishing systems, copiers, printers, scanners, fax machines, and document management software, as well as related products and services, in over 130 countries. In 1996, they had revenues of $17.4 billion, and employed 86,700 persons, including 46,000 in the U.S.

In 1990, Xerox Corporation embarked upon a strategy to reduce waste in their products and facilities, and to promote the recycling and recovery of Xerox products. The company developed the Environmental Leadership Program, which seeks to promote environmental excellence in all aspects of the Xerox Corporation's operations and products. Product stewardship initiatives are coordinated through two programs: Asset Recycle Management and Design for Environment. The ultimate goal of these programs is zero waste to produce waste-free products in waste-free facilities.

7.2 BACKGROUND OF ENVIRONMENTAL STEWARDSHIP AT XEROX

Xerox Corporation has always worked towards a proactive environmental corporate image. In 1967, Xerox started reclaiming metals from its photoreceptor drums, resulting in both reduced manufacturing costs from using recycled metals and decreased hazards associated with disposal of the drums. In the 1970s, Xerox stopped using polychlorinated biphenyls in most components, and in all newly designed products and production processes.[2] In 1992, Xerox set an internal policy to eliminate ozone-depleting substances from all manufacturing processes and operations by mid-1993, well ahead of the U.S. commitments under the Montreal Protocol. Xerox has also been a committed member of many voluntary EPA waste reduction and pollution prevention programs, such as GreenLights, WasteWi$e, the 33/50 program, and Energy Star copiers and printers.

In 1980, the corporate Environmental, Health, and Safety Department (EH&S) was established. Xerox has developed a structured, systematic approach to environmental management based upon existing management practices. EH&S processes are integrated within a comprehensive system that builds upon the "Leadership Through Quality" program concepts, processes, and principles used throughout Xerox. Senior management involvement and leadership is key to the system's success. The EH&S policy includes the following goals:

- Protection of the environment and the health and safety of employees, customers, and neighbors from unacceptable risks takes priority over economic considerations and will not be compromised.
- Xerox operations must be conducted in a manner that safeguards health, protects the environment, conserves valuable materials and resources, and minimizes risk of asset losses.
- Xerox is committed to designing, manufacturing, distributing and marketing products and processes to optimize resource utilization and minimize environmental impact.
- All Xerox operations and products are, at a minimum, in full compliance with applicable governmental requirements and Xerox standards.
- Xerox is dedicated to continuous improvement of its performance in Environment, Health and Safety.[3]

In addition to its corporate commitment to environmental protection, there were a number of drivers for developing a more proactive environmental program at Xerox. An initial driver in the U.S. was public concern over landfilling of waste and growing public promotion of recycling. Further, through its international business operations, EH&S became aware of the growing concerns in Europe over waste disposal, and burgeoning discussions of manufacturer responsibility. Xerox also realized that taking a proactive stance on waste reduction and recycling would give them a competitive advantage. Xerox created multinational quality improvement teams to assess packaging specifications, facility recycling programs, and waste management policies. EH&S managers concluded that a company-wide plan for Total Environmental Quality Management was necessary.[4]

The director of EH&S, James MacKenzie, and Jack Azar, Associate Director, Environmental Products and Technology, developed a strategy called the Environmental Leadership Program, which consisted of four components: a cartridge recycling program, a supplies project, an asset management initiative, waste reduction and recycling. Employee involvement was used to drive the strategy. The program components emphasized the Xerox commitment to quality as well as enhancing the reuse and remanufacture of Xerox machines. Initial assessment of savings potential for the expansion of reuse and recovery programs suggested savings potential from a conservative estimate of \$10 to \$20 million annually to more than several hundred million annually.[5]

7.3 ASSET RECYCLE MANAGEMENT

Asset management is the process of reusing an asset (machine, subassembly, piece part) either by remanufacturing to its original state, converting to a different state, or dismantling to retrieve the original components.[6] Asset Recycle Management (ARM) at Xerox is defined in its mission statement as "a worldwide asset recycle organization that provides strategic planning, new product technical support, and environmental linkages to enable the business divisions and their customers to achieve corporate priorities through profitable utilization of unserviceable parts and equipment consistent with environmental goals."[7]

The project goals are to attain "waste-free" factories by 1998 by:

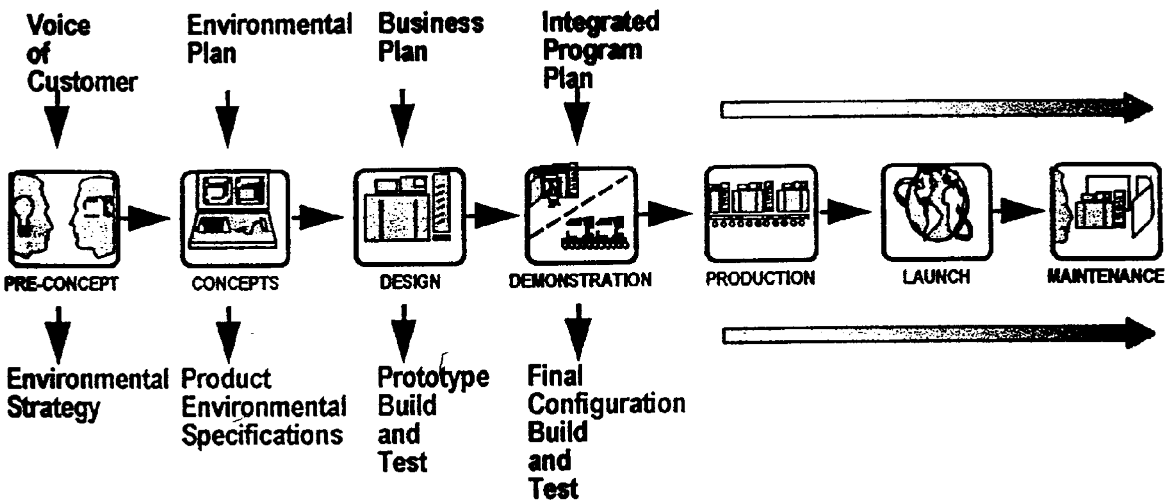
- Achieving a 90 percent decrease in municipal, hazardous, and chemical waste.
- Achieving a 90 percent decrease in air emissions.
- Achieving a 50 percent decrease in water discharges.
- Achieving a 25 percent increase in purchases of post-consumer materials.
- Achieving a 10 percent increase in energy efficiency as compared to each facility's baseline.[8]

While Xerox had been taking back machines through their leasing programs, their manufacturing facilities had not been developed with total recycling of machines in mind. The "return" process required equipment to be sent to a central warehouse facility, which represented additional expenses to the company in both handling and warehouse costs. Further, as field returns accumulated, there were inventory control problems and scrapping of equipment and parts. Xerox quickly realized that the method in which they accepted returns, processed, and recycled them would need to change to implement the ARM Program.[9]

7.3.1 The Product Delivery Process

In 1993, environmental and asset recovery considerations were incorporated into Xerox products through the Product Delivery Process (PDP). Xerox adopted a "focus-factory" concept that integrated new-build and remanufacturing lines to facilitate consistent use of existing manufacturing tools, processes, and product quality controls. An assessment process was developed for all products in development that essentially provides checkpoints throughout each phase of product development (Figure 7-1). If potential problems are discovered, the PDP can serve to halt development of the product if the issue is considered critical, or an action plan will be created and implemented to rectify the concern.[10]

Figure 7-1: Product Delivery Process



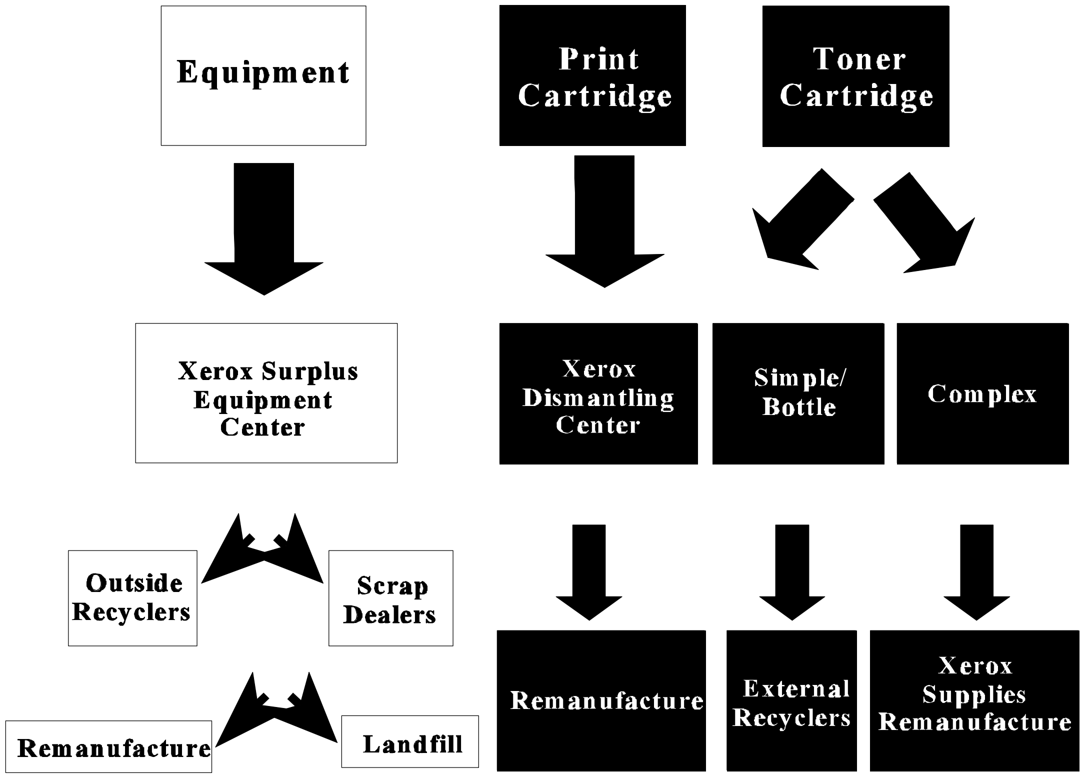
Source: Azar, J., et al. 1995. IEEE International Symposium on Electronics and the Environment.

Environmental and asset recovery considerations are built into each phase of the PDP. During the Pre-Concept phase, the potential markets and customers for the product are established. In the Concept phase, general product strategies are translated into environmental and asset recovery plans, design teams work on designing for asset recovery, and environmental design end points are incorporated into product design specifications. The environmental design end points include requirements such as inclusion of parts made of 25 percent post consumer resin, use of recyclable thermoplastics, and minimization of emissions. During the Design phase, a prototype is created and evaluated for remanufacturability and recyclability, which is then compared to environmental performance criteria. Before the prototype can move to the Demonstration phase, it has to go through a design exit review that includes criteria for meeting the material utilization and emissions endpoints. If the product meets all the end point requirements, it is at this phase that capital tooling commitments and supplier commitments are formalized.[11]

7.3.2 Equipment Recycling Process

After machines have served their useful life or after termination of a lease, the machines are returned to a dedicated recycling center. The returned equipment is then separated to either be remanufactured or stripped down for part and material recovery (see Figure 7-2).

Figure 7-2: Xerox Recycling Processes



Source: Azar, J. 1996. PCSD Workshop on Extended Product Responsibility.

Field returns that meet remanufacture criteria follow disassembly and reassembly processes. After data recording and damage checks, external covers, subassemblies, and parts are removed. All pieces are sorted according to their remanufacture codes, cleaned, and refurbished to new part standards. Repaired parts are returned to manufacturing for use in second generation equipment. Parts and assemblies that are too damaged for remanufacturing are scrapped to recover the metal and plastic content.[12]

Due to the corporate commitment to ARM, the percentage of remanufactured machines has more than doubled in the last five years. In addition to the environmental successes of asset recovery at Xerox, the ARM program has been an enormous financial success. In the first twelve months of the program, ARM saved over $50 million due to changes in logistics, inventory, and raw materials purchasing.[13] Estimated savings to Xerox in 1995 alone exceeded several hundred million dollars, and the company feels that there is the potential for greater savings in the future. By accounting for environmental and remanufacturing conditions in the design process, Xerox will achieve higher paybacks and faster time to market.[14]

7.4 DESIGN FOR ENVIRONMENT

Following on the initial success of the ARM program, Xerox developed a full-scale Design for Environment (DFE) initiative. The goal of the DFE program is to produce waste-free products. DFE at Xerox includes the following criteria:

- Satisfaction of all current and future regulatory requirements.
- Satisfaction of criteria defined by major environmental labeling programs such as the U.S. EPA's Energy Star and Germany's Blue Angel.
- Satisfaction of customer environmental requirements.
- Satisfaction of internal requirements for remanufacturing and environmental protection.[15]

Xerox has designed several tools that facilitate the inclusion of Design for the Environment in the PDP and product manufacturing phases. These include signature analysis, remanufacturing coding, and design for assembly software. Signature analysis is a diagnostic tool for manufacturing that incorporates a sophisticated methodology for determining the remaining life and performance potential of a component or part after it is recovered. Design for assembly software, still to be developed at Xerox, will be utilized to evaluate product designs to improve quality, cost, delivery, and to quantify assembly times. This software tool is being developed to assist design teams in optimizing disassembly, recyclability, and environmental design. Remanufacturing coding is a system to optimize for part and assembly remanufacturing. The coding procedure is included on engineering drawings and the engineering documentation information system for the product. Disposition codes come into play when a part or assembly is no longer acceptable for remanufacture, and help to ensure maximum asset utilization and proper control over the environmental fate of all parts, components, and assemblies.[16]

A design principles matrix was also developed to further ensure that general environmental design guidelines and standards are incorporated into all Xerox products. This matrix is used by the design engineer to facilitate the interactions of various design features, such as ease of assembly, disassembly, remanufacturing, servicing, and recycling (see Table 7-1). Some of the general principles used to promote design for disassembly are modularity, no metal inserts, snap in/out (or breakout inserts), mold-in color, less use of adhesives, or use of compatible adhesives. To promote ease of serviceability, design guidelines include accessibility of equipment, tools, modularity, minimizing adjustment and test time.[17]

To facilitate efficient recycling, several principles are emphasized. The use of compatible materials, especially plastics, is necessary. Many fewer plastics are used now, and Xerox is driving toward use of 100 percent thermoplastic resin formulations. All plastics are marked according to ISO standards. Also, the use of paper labels has been curtailed to reduce contamination of plastic materials.[18]

Another DFE tool used by Xerox is a financial model developed to enable design engineers to assess tradeoffs between life-cycle costs and various design parameters. Based on a net present value model, it incorporates such inputs as material selection, remanufacturing return on investment, and disposal costs at end of life. This allows Xerox engineers to conduct sensitivity analysis between product cost changes and total life cost.[19]

Table 7-1: Design Principles Matrix

Design Features	Affected Activity				
	DFA	Asset Recovery Management			
		DFD	Service	Reman	Recycle
Part consolidation		U	U	U	U
Design parts to be multifunctional		U	U	U	U
Use standard components and processes	U	U		U	
Develop a modular design approach	U	U	U	U	U
Minimize orientation of parts	U		U		
Facilitate insertion/alignment	U	U	U	U	U
Minimize assembly direction (top down preferred)	U		U		
Maximize compliance/self alignment	U			U	
Reduce fasteners, springs, pulleys, harnesses		U		U	U
Minimize adjustments		U	U	U	
Design for commonality	U	U	U	U	U
Do not design from emotion	U				
Utilize similar materials	U	U	U	U	U
Minimize use of adhesives		U	U	U	U
Utilize marketing codes		U	U	U	U
Utilize molded - in color	U	U	U	U	U

Source: Bark-Boateng, V., et al. 1993. IEEE International Symposium on Electronics and the Environment.
Key: **U** Applies in all cases
DFD - Design for Disassembly
DFA - Design for Assembly

7.5 OTHER EPR INITIATIVES AT XEROX

As part of their product stewardship initiatives, Xerox has made been working to successfully involve their customers in returning Xerox equipment and components for recovery and recycling. Two programs that demonstrate the customer partnerships with Xerox are the Copy and Print Cartridge Return Program and the Toner Container Return Program.

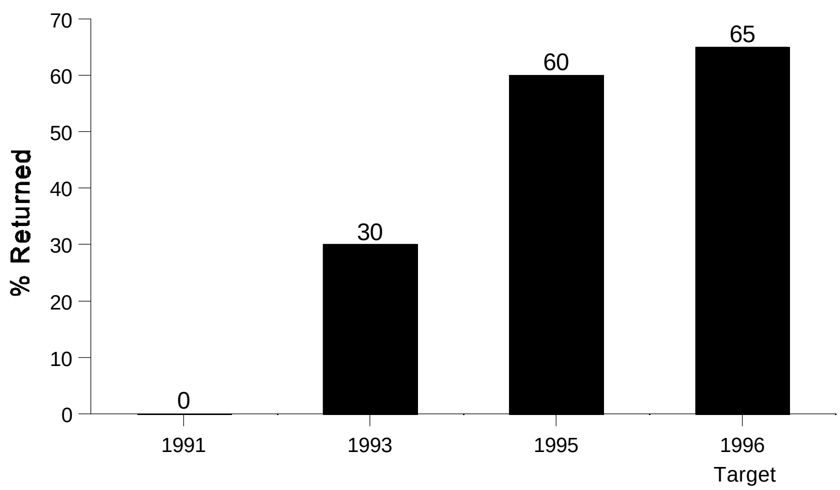
7.5.1 Copy and Print Cartridge Return Program

Launched in 1991, the Copy Cartridge Return Program has become a very successful program for Xerox. The copy cartridge was initially chosen as a possible target for take back, reuse, re-manufacturing, and recyclability for several reasons. Since 1988, the copy cartridge had been a replaceable part. The cartridge represented a fairly self-contained part that could be designed to be remanufactured and reused. Additionally, other competitors were advertising the take back and recycling of copy cartridges in their equipment.[20]

The Copy Cartridge Return Program created by Xerox was designed to be as simple for the customer as possible. Initial return rates in 1991 were low at approximately two percent, so Xerox had a sales and marketing team investigate the types of program features that would be most useful to customers. Ensuing changes to the program included providing pre-paid return mailing labels to customers who bought or leased cartridges, and discounts were provided to customers who bought the cartridges on the condition that they be returned for re-manufacture. The cartridges are returned to Xerox in their original packaging, with Xerox paying for the return costs. Xerox also encouraged the return of all cartridges, including those older cartridges not designed for remanufacturing and recycling. While this represented an additional expense and a recycling challenge, Xerox felt it necessary to the long-term success of the program.[21]

The number of cartridges returned to Xerox has climbed steadily every year, with a worldwide cartridge return rate of approximately 60 percent in 1995. This represents a landfill diversion of approximately 1,100 tons of material (see Figure 7-3). Program goals for 1996 include achieving a return rate of 65 percent, which Xerox plans to accomplish by making the program even more convenient to the customer and developing stronger environmental messages regarding the product.[22]

Figure 7-3: Worldwide Return Rate - Xerox Copy & Print Cartridges



Source: Azar, J. 1996. PCSD Workshop on Extended Product Responsibility

7.5.2 Toner Container Return Program

Based on the success of the Copy Cartridge Return Program, Xerox initiated a Toner Container Return Program in 1995. Toner containers have traditionally been difficult to recycle due to residual toner and low economic value. However, the toner program is part of a 3Rs program, to reduce, reuse, and recycle materials in supplies packaging. Xerox redesigned their toner containers in several ways: they lightweighted the containers, saving over 500 tons of material in two years and reducing the financial and environmental costs of shipping. Xerox also qualified 100 percent post-consumer plastic for use in the production of toner containers and has redesigned some cartridge assemblies for reuse and recycling.[23]

Xerox launched its Toner Container Return Program on Earth Day, 1995, making it the first program of its kind in the industry. The customer return process is similar to the Copy Cartridge Return Program - customers re-box empty toner containers in their original packaging and return them with shipping costs paid by Xerox. The containers are cleaned, inspected, and then refilled or recycled.

While the Toner Container Program is still too new to fully evaluate its success, it has the potential to reuse or recycle 80 percent of Xerox toner containers and annually divert more than 1000 tons of plastic from the wastestream. So far, over 500,000 toner containers have been returned, and customer response has been very enthusiastic.[24]

7.6 CONCLUSIONS

Xerox Corporation has made a significant voluntary commitment to product stewardship and environmental protection in its global products and facilities. In working towards the Xerox goal of developing waste-free products in waste-free facilities, notable achievements include:

- In 1995, Xerox achieved an overall solid waste recycling rate of 80 percent at its 17 largest sites worldwide, up from 56 percent in 1991; these recycling programs have saved the company over $12 million in 1995, and reduced waste to landfill by 15 percent since 1994.
- In 1995, 70 percent of Xerox' new product programs included environmental features, up from 25 percent in 1994.
- Annually, Xerox' product stewardship programs save several hundred million dollars.[25]

With the assistance of management leadership and involving Xerox employees at all levels, Xerox Corporation has proven that product stewardship can be highly cost effective over a product's life cycle, and can promote a better competitive position in todays global marketplace.

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Chapter 8

ROCHESTER-MIDLAND CORPORATION'S LIFE-CYCLE PARTNERSHIP FOR CLEANING PRODUCTS

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"Strategically, our focus is on developing innovative new products which incorporate tight environmental and human safety criteria, educating customers and the broader marketplace, working closely with product users, and developing a team approach to substantially differentiate ourselves from the competition."

Stephen P. Ashkin, Vice President, Rochester-Midland

8.1 INTRODUCTION

Rochester Midland Corporation is a chemical specialty manufacturer producing, among other products, cleaning products for institutional building cleaning. By developing a new line of cleaning products with environment, health, and safety in mind and by forming a unique "life-cycle partnership" with an institutional cleaning service, a government building manager, and the tenants of a large government building, Rochester Midland demonstrated the benefits of extending product responsibility in this highly-competitive industry.[1]

Cleaning products have been a focus of environmental, health, and safety concerns because of the numbers of people who are exposed to them in homes, schools, hospitals, and offices and because of the large volume used. In addition to the millions exposed by simply spending the majority of their hours indoors, approximately 2 million workers are employed in janitorial/custodial jobs where they receive significantly higher exposures. The market for cleaning products is in the $5 billion range and represents about 5 billion pounds of product annually. Exposure of janitorial workers to organic solvents and corrosive chemicals used in institutional cleaners is a major health and safety concern. Furthermore, the use of certain cleaning products in office and public buildings has contributed to indoor air quality problems and to the "sick building syndrome," which often results in worker complaints and lost productivity.[2]

Recently the President's Council on Sustainable Development Eco-Efficiency Task Force assessed opportunities for pollution prevention and product stewardship in the commercial cleaning products market. The Cleaning Product Stewardship Project Team, which was a multistakeholder team of producers, users, government representatives, and environmental organizations, took an in-depth look at how cleaning products are made, how they are applied, and how these processes could be improved. The Team found that lack of sufficient information concerning environmental, health, and safety considerations for selection of cleaning products hampers pollution prevention and product stewardship, that information provided by producers is generally not well-understood by cleaning personnel, and that the practices used by cleaning personnel are frequently inefficient, leading to overuse of cleaners, because the cost of cleaning products themselves is relatively insignificant compared to the costs of labor for cleaning. Among the recommendations of the Project Team was the recommendation that a partnership should be created with members from the entire building cleaning chain of commerce to develop a plan based on the life-cycle perspective for extending eco-efficiency throughout the chain of commerce.[3]

Rochester Midland has demonstrated this type of life-cycle partnership within its own chain of commerce. As a result of the application of Extended Product Responsibility (EPR), the company has developed improved products, has developed closer relationships with the users of its products, and has improved the overall performance of building cleaning.

8.2 FEDERAL BUILDING DEMONSTRATION OF THE GREEN BUILDING HOUSEKEEPING AND MAINTENANCE PROGRAM

To demonstrate this new EPR strategy, Rochester Midland entered into an informal life-cycle partnership for a 36-story federal office building in New York City with a cleaning service provider (WECO), a federal building manager (U.S. General Services Administration [GSA]), and the building tenants (U.S. Environmental Protection Agency [EPA]). The 3-year-old office complex houses offices for the EPA Region 2 and other federal government agencies. While this particular demonstration was undertaken at a federally-owned building with EPA as the tenant, Rochester Midland believes that the strategy is applicable for any building regardless of the owner or tenant.

The demonstration got its start as a result of concerns about how the housekeeping program and cleaning products were affecting some of the building occupants. EPA requested that the building manager and cleaning contractor, GSA and WECO, evaluate the impacts of the existing cleaning program for the building. Rochester Midland Corporation was contacted to help solve the problems because both GSA and EPA were familiar with the company's work on activities related to environmentally preferable products and the leading role of the company in the ASTM Task Force that is currently writing the voluntary national standards on Cleaning Commercial and Institutional Buildings.[4]

The demonstration project was begun in May 1996. The first step in the Green Building Housekeeping and Maintenance Program was the building of the life-cycle partnership through commitment from the senior management of each of the partners. Goals and expectations were clearly defined by senior management as were implementation plans with time tables by which the program could be evaluated. Next a project team was assembled that included senior organizational representation from GSA, EPA, WECO and Rochester Midland, plus specific individuals within the building who had expressed concerns about the existing cleaning practices or the general quality of the indoor environment. It is important to note that those representing the tenants (EPA) included several layers within the organization, including senior managers, representatives of the employee Health & Safety Committee, and those individuals who were particularly affected.

Through project team meetings with all stakeholders, the following goals for the demonstration were identified:

- Demonstrate that a focus on human health and safety and the environment would positively affect building occupants and could be done within cost and other performance requirements.
- Address the needs of those individuals adversely affected by the cleaning products and processes. Identify potentially hazardous products and processes. Identify opportunities to reduce risk to occupants.
- Address the needs of the cleaning personnel by identifying processes that were potentially hazardous and to reduce those risks. Identify training and communication requirements on product use, storage, and disposal.
- Address the use of cleaning products to identify opportunities for up-front source reduction in terms of both quantity and toxicity, and to utilize engineering controls for consistent quality and efficiency of cleaning.
- Identify alternative cleaning products that meet all requirements, including economics, efficacy, and other opportunities consistent with the fundamental objectives of the tenant and building owner, including Executive Order 12873 for “environmentally preferable” products and Executive Order 12856 for pollution prevention opportunities.

With these goals the partnership evaluated the existing products and services to determine if better alternatives are available. As a result of a facility survey and interviews with some of the building occupants who had expressed concerns over the existing program, it was determined that the replacement of several products and the implementation of new procedures could positively impact the indoor environment and meet the project goals.

The second step was the selection of cleaning products to use for the demonstration. The existing cleaning contract provided that the contractor selected the cleaning products as part of their service. While the cleaning products previously used by the cleaning contractor were effective, it was found that several of the products contained ingredients, such as petroleum distillates and strong fragrances, that were particularly troublesome to some of the more sensitive building occupants. Rochester Midland’s Enviro Care cleaners were selected as the alternatives for the demonstration. They are specifically designed by Rochester Midland for safety to the product users, tenants and the environment, in addition to meeting price and performance requirements (see Section 8.3).

The third step was to evaluate and modify cleaning procedures based on the specific requirements of individual areas in the building, such as for the office spaces, high traffic areas, restrooms, and conference rooms. Furthermore, specific procedures were developed to address individual building occupant needs. These occupants include asthmatics, chemically sensitive individuals, and other at-risk populations.

Step four involved training for cleaning personnel to ensure that appropriate cleaning procedures were learned and were being followed. Training was also instituted to inform the cleaning personnel of issues relating to chemical and equipment safety.

In step five engineering controls were installed to provide consistent product quality, greater health and safety protection, and reduced risk associated with the incorrect or accidental mixing of chemicals. This included the use of the Chemizer Chemical Management system, which not only provides safer and more efficient chemical mixing, but also reduces overall chemical use.

Finally, step six involved the development of communication vehicles to provide feedback loops between building management, building occupants, cleaning personnel, and the supplier. These communication vehicles were designed to foster the team effort and develop a clear sense of shared responsibility, as well as to establish a framework for continual improvement.

The Green Building Housekeeping and Maintenance Program was implemented on three floors of the 36 story office building, with another 3 floors used as a control for comparison. Because previous indoor air sampling had failed to identify excessive levels of contaminants of concern, the partners agreed that the measure of success for the demonstration would be the numbers of complaints from building occupants instead of relative levels of air contaminants.

Trials of the improved cleaners and cleaning processes were implemented during summer 1996. Complaints from building occupants were significantly reduced on the three floors with the alternative cleaners and processes despite increased attention engendered by the demonstration project. EPA decided to implement the Green Building Housekeeping and Maintenance Program on all nine floors it occupies in the building, and GSA has expressed interest in implementing the approach in other buildings it manages. Furthermore, as a result of improved chemical management, overall chemical consumption was reduced by approximately 50 percent, reducing resource use, packaging waste, and releases of cleaning chemicals into the environment.

8.3 DEVELOPMENT OF ENVIRO CARE PRODUCTS BY ROCHESTER MIDLAND

In October 1993, when President Clinton authorized Executive Order 12873, requiring the use of environmentally preferable products by federal agencies, a new market for greener cleaners was born. By utilizing the $200 billion of annual purchasing power of the federal government, the Executive Order has encouraged companies like Rochester Midland to heighten their efforts to develop innovative products with the environment in mind and will ultimately impact whole markets, public and private, throughout the chain of commerce.

Historically, development of new products at Rochester Midland, as at other companies, was based primarily on improved performance, first, followed by reduced price and improved safety. In developing the Enviro Care line of products in the 1980s, however, Rochester Midland placed environmental performance first, with product performance second. The company established an explicit goal of developing environmentally preferable products, defined as products which have a lesser or reduced effect on human health and the environment when compared with competing products that serve the same function.

Rochester Midland's development of environmentally preferable products was presaged by its patenting of the use of citrus-based cleaners as replacements for petroleum-based cleaning products in the early 1980s. This new product provided first-hand experience that product efficacy did not have to be sacrificed to reduce impacts on the environment and the health and safety of product users. In 1990, after several years of research, development, and test marketing, the Enviro Care Program was introduced to the company's institutional customers for floor and carpet care systems and for general building maintenance and cleaning.

One of the difficult tasks in developing environmentally preferable products encountered by Rochester Midland is the identification of metrics for determining the overall environmental performance of the products and comparing that performance to other products with the same function. The overall criteria developed by Rochester Midland for the Enviro Care line require the products to be:

- Non-toxic.
- Phosphate free.
- Biodegradable.
- Non-corrosive.
- Non-combustible.
- Non-reactive.
- Free of hazardous ingredients.
- Free of glycol ethers.
- Free of petroleum distillates.
- Free of harsh acids.
- Free of alkalis.
- Free of ozone-depleting chemicals.
- Free of suspected carcinogens.
- Formulated with a preference for rapidly renewable natural resources.

Rochester Midland has developed specific criteria for each of these general criteria or relies upon established tests and standards for each of these general criteria.

The Enviro Care product line developed by Rochester Midland consists of four product types with four basic chemistries. These four chemistries are intended to serve as a technological foundation for continuous improvement of the efficacy and environmental performance of the products.

First is an all-purpose cleaner based upon alkyl polyglycosides as the major surfactant. Alkyl polyglycosides are produced from plant sugars and vegetable oil fatty alcohols and clean effectively at neutral pH. They are also readily biodegradable and exhibit low toxicity.

The second type is a tough job cleaner for oily/greasy soils, which contains a mixture of citrus-based solvent and surfactants. This cleaner is non-corrosive and derived from renewable resources.

The third type of cleaner is a washroom and fixture cleaner, which has the added requirement of removing tarnish from metal components of sinks and toilet fixtures. The product developed is a mixture of the alkyl polyglycoside surfactant, buffered with ammonium citrate. The product is mildly acidic.

The fourth type of cleaner is a hand soap, which can be produced from vegetable oils or alkyl polyglycolsides. These can include a variety of additives produced from renewable resources that enhance foam, improve performance in hard water, and soften the skin.

Today, the Enviro Care Program is the fastest growing Program in the company. At least partly through the introduction of the new chemistries, Rochester Midland has accomplished an approximate 25 percent decrease in chemical releases under the Toxics Release Inventory since 1993 despite significant increases in production. Rochester Midland also has active projects to evaluate the overall environmental performance of the products through life-cycle assessment.

8.4 DRIVERS FOR AND BENEFITS OF THE PROGRAM

The Rochester Midland Green Housekeeping and Maintenance Program and the Enviro Care products development have had several sets of drivers. From the Rochester Midland point of view, the most significant driver is the opportunity to sell new products to a new market. Being in the forefront of marketing environmentally preferable products to federal agencies and cooperating in the demonstration project with the EPA has been a means of showcasing Rochester Midland’s leadership in this new marketplace.

Rochester Midland also sees real advantages to the type of life-cycle partnerships that were built in the Green Housekeeping demonstration project. One advantage is the opportunity to influence the selection of cleaning products by cleaning contractors through specifications of environmentally preferable products by building managers. Another is the opportunity to create a new market for cleaning services, not just cleaning products. Finally, the communication with building tenants, building managers, and cleaning contractors provides valuable information for improving the performance of the company’s products.

From the standpoint of building managers and building tenants, in this case GSA and EPA Region 2, the principal driver for a Green Housekeeping Program and the life-cycle partnerships demonstrated in this case is to alleviate indoor air quality problems that lead to complaints and lost productivity from building occupants. The demonstration project reduced exposures of highly affected individuals to the cleaning products and processes. In addition to the health benefits to those individuals, this improvement also resulted in improved productivity for the building occupants due to their reduced absenteeism and increased tenant satisfaction. GSA, the building manager, benefits from the added customer satisfaction in a time when federal agencies have more flexibility for leasing office space. Additionally, GSA benefits in terms of their increased ability to protect their building assets and to reduce potential liability from building occupants. From the tenant point of view, not only was EPA able to meet the needs of its personnel for a safe and comfortable work environment, it was also able to support its organizational mission by promoting environmentally preferable products and preventing pollution.

From the standpoint of cleaning contractors, the principal driver for WECOs participation in the demonstration project was the potential loss of business due to the complaints from building tenants concerning indoor air quality. Turning this problem into an opportunity to increase customer satisfaction through the adoption of alternative cleaning products and practices can only increase marketing opportunities for cleaning contractors, as long as prices do not increase. An even greater benefit over the long term, however, is the reduced risks to cleaning personnel associated with cleaning product usage. This reduced risk comes, in part, from the use of safer cleaning products, but it also comes from improved training and communication for cleaning personnel and from a reduction in the overall quantity of chemical cleaning products used to clean the buildings. The reduced risk reduces potential liabilities for cleaning service companies, and the involvement of cleaning workers in improving their practices increases their pride and professionalism.

8.5 BARRIERS ENCOUNTERED IN THE PROGRAM

There were both technical and non-technical barriers encountered in the implementation of the Green Building Housekeeping and Maintenance Program by Rochester Midland and its partners. The chief technical barriers for Rochester Midland were the development of environmental criteria for the new Enviro Care products and the development of the products themselves. There currently are not any universally accepted criteria for environmentally preferable institutional cleaning products, although one environmental labeling organization, Green Seal, has finalized a standard for household cleaners. EPA has developed general principles for purchasing environmentally preferable products to be used by federal agencies, but those principles are not specific as to which environmental impacts to consider, which ingredients to prefer or avoid, or how to make tradeoffs among disparate impacts that occur throughout the life cycles of different products and different ingredients. Rochester Midland developed a list of criteria through its own research, with reference to existing standards, and then selected product formulations that could meet those criteria while meeting other criteria for safety, performance, and cost.

Other technical barriers included the lack of standards for the cleanliness of buildings or for indoor air pollution. Without these standards, measuring improvements in the performance of cleaning products and alternative cleaning procedures is difficult. It would be difficult, if not impossible, to develop a standard for the cleanliness of buildings, because there are so many different types of buildings, building environments, building users, and soils to be cleaned. As for indoor air pollution, while workplace standards have been set for a few contaminants, it is usually difficult to determine the particular contaminant or contaminants causing discomfort and symptoms of illness among occupants. Furthermore, in many cases, the concentrations that cause discomfort or symptoms in sensitive individuals are well below occupational standards and often below detection levels.

Non-technical barriers included the usual organizational inertia which resists change. In this case, the development of Enviro Care products was impeded by Rochester Midland's own internal competition for research and development resources. The cleaning contractor was reluctant to change cleaning products and cleaning procedures because of the familiarity of the existing products and procedures. Building managers are reluctant to change contracts for cleaning and usually only consider cleaning a priority when there are problems. Building occupants are also reluctant to take time and resources from their primary tasks to get involved with a function that is normally invisible to them.

Another non-technical barrier that can be overcome by demonstrations such as this one is the widely-held belief that products which are safer for the user and the environment are either too expensive or lack the efficacy of traditional products. Rochester Midland is seeking to dispel this belief by working with cleaning contractors and building managers in a way that can secure competitive advantage for its products and services.

8.6 CONCLUSIONS

Rochester Midland has demonstrated the benefits of EPR to the producer and users of cleaning products through an expansion of the product stewardship concept. While product stewardship has traditionally meant providing information and guidance to purchasers of chemical products to ensure that they are used safely, Rochester Midland expanded the concept to incorporate both product redesign and unique life-cycle partnerships with those directly impacted by the use stage of the life cycle. As a result, the company has helped redefine the service of building cleaning to incorporate environmental and health considerations and has created a strong niche for itself in the expanding market for environmentally preferable products.

At a time when there is much confusion about and resistance to the federal purchasing directive for environmentally preferable products, Rochester Midland has developed explicit criteria for the health and environmental performance of its Enviro Care line of cleaning products. These criteria were drawn from those developed by standard-setting organizations, and the company believes they are defensible for specific environmentally preferable claims. Rochester Midland has also developed product formulations to meet those environmental criteria that it claims perform as well and are no more costly than conventional formulations.

The Green Building Housekeeping and Maintenance Program redefined the service of building cleaning by looking at the building as a whole, taking into account the specific cleaning needs, plus any unique requirements of cleaning personnel and building occupants for impacts that are caused by or can be corrected by cleaning operations. The demonstration project also showed that while utilizing the safest cleaning products available is essential, a critical and often overlooked element of a successful program is ongoing training for cleaning personnel on product usage and procedures.

ENDNOTES

1. This case study is based primarily upon information provided by Stephen Ashkin, Vice President, Rochester Midland, including the presentation at the President's Council on Sustainable Development Workshop on Extended Product Responsibility, Washington, D.C., October 21-22, 1996.

2. U.S. Environmental Protection Agency. 1991. Indoor Air Facts No. 4: Sick Building Syndrome. World Wide Web http://www.epa.gov/iaq/pubs/sbs.txt. April.

3. President's Council on Sustainable Development. 1996. *Eco-Efficiency Task Force Report*, Washington, D.C., pp. 38-39, Appendix B3.

4. An ASTM Task Force has developed a draft Standard Guide on Stewardship for Cleaning Commercial and Institutional Buildings that is under consideration within an ASTM Technical Committee. Stephen Ashkin of Rochester Midland is the Chair of the Committee and can be reached for information about the draft standard at Rochester Midland Corporation, 333 Hollenbeck Street, Rochester, NY 14621.