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# FLEXIBLE STRATEGIC FRAMEWORK FOR MANAGING CONTINUITY AND CHANGE IN REVERSE SUPPLY CHAIN IN THE BATTERY INDUSTRY - STUDY OF LEAD ACID BATTERIES AND NI CD BATTERIES FOR AUTOMOTIVE, COMPUTERS AND MOBILE PHONES

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**ABSTRACT**

*While many companies have yet to recognize the strategic potential of efficient reverse supply chain (commonly referred to as reverse logistics), it is clear that there is more interest in reverse logistics now than ever before. Firms are beginning to make serious investments in their reverse logistics systems and organizations. One clear indication of the strategic importance of a business element is the amount of money spent on managing that element. Given the volume of returned products experienced in some industries, it is not surprising that the firms in those industries consider returns a strategic and core competency. It appears likely that companies in industries that generally do not place much value on good reverse logistics practices, will, over the next few years, find that making investments in their return systems will enhance their profitability. It is clear that for many firms, excellent reverse logistics practices add considerably to their bottom line.*

*Throughout Europe, there is a strong trend towards producer product take-back. In some countries, some industries are under voluntary take-back programs, in which the government and industry have agreed to targets that the industry will attempt to meet. If these targets are not met, these industries may find themselves under mandatory targets. For a Reverse Supply Chain Expert, different challenges are present in different countries, in different industries. In some industries, the government does the collecting, such as, in the Swedish battery industry. In some cases, a network of facilities is organized and run by the industry, like the Swedish auto industry, for example. In other cases, companies are left to create their own centers. The money to pay for these systems comes in as many ways as the systems themselves. In some cases, the industry must bear the cost, in some cases the user pays for disposal at the time of the product's purchase, and yet in other cases there are combinations of payment arrangements. In this project a study of various companies in the battery industry has been carried out. The focus has been on flexible strategic framework for managing forces of continuity and change in reverse supply chain in battery industry.*

*Keywords: Reverse Supply Chain, Battery Industry, Automotive, Computers, Mobile Phones*

## Introduction

This research project was aimed at defining the state of the art in Reverse Supply Chain Management (also called as reverse logistics), and to determine trends and best reverse supply chain practices emerging in view of forces of continuity and change affecting the business. Most of the literature examined in preparation for this research emphasized the "Green" or

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environmental aspects of reverse logistics reflecting the forces of change. The objective was to determine current practices, examine those Practices, and develop information surrounding trends in reverse Logistics practices especially for batteries for automotives, computers and mobile phones in view of the forces of continuity and change.

**Literature Review**

According to David Diener, Eric Peltz[1] Value recovery in the form of the return and repair of reparable spare parts involves large amounts of time as well as inventory investment for the Army. This research defines metrics to evaluate the retrograde processes and establishes a baseline of performance based on fiscal year 2000. In that year, approximately 603,000 individual unserviceable Class IX items valued at almost $2 billion were handled Army-wide by organizations below depot repair activities. Almost half of those items were repaired and returned to serviceable stocks; many were relatively inexpensive items. A significant dollar value also left Army inventories in the form of disposals or condemnations, although the bulk of the items were individually of low value. Reparable are important because they are intended to be their own source of future serviceable. By definition, a “reparable” is an item that can be reconditioned or economically repaired for reuse when it becomes unserviceable. As part of a Level of Repair Analysis, the Army decides which parts should be repaired so that they can be used again, i.e., which parts are to be reparable rather than consumables that are automatically disposed of upon failure. Reparable are typically more expensive investment items that should be expeditiously moved to repair points for repair/refurbishment/remanufacture and to return these to serviceable stocks so as to minimize the amount of inventory investment.

According to Frank Schultmann and Bernd Engels[2] in Germany, a battery decree prescribes measures for collecting and recycling spent batteries. They developed a hybrid approach to establishing a closed-loop supply chain for spent batteries that combines an optimization model for planning a reverse-supply network and a flow-sheeting process model that enables a simulation tailored to potential recycling options for spent batteries in the steel making industry. Their results show that almost complete recycling of spent batteries can be achieved by transforming the current structure into a modified recovery network. According to Alicia Culver[3] Government faces enormous costs in handling computer waste, as equipment often has to be replaced every few years. Computer owners are likely to face even higher waste management costs now that several states have moved to restrict the disposal of computer monitors (and televisions) from trash incinerators and landfills because these items contain up to 8 pounds of lead and other toxic chemicals. From the vendor’s perspective, including the cost of recycling in the product’s purchase price virtually guarantees loss of low-bid contracts unless there is a level playing field. Under a contract with take-back provisions, companies that devise strategies to cost-effectively collect; reuse, and recycle used computer equipment will gain a competitive edge. The second strategy that returns used computer equipment to manufacturers or resellers is leasing. Under certain leasing agreements, vendors automatically take back their equipment at the end of the lease term. Leasing guarantees purchasers up-to date technology and is catching on, in large part because of the short life span of computer equipment.

Fishbein[4] propagated the concept of EPR**.** The term “extended producer responsibility” (EPR) was coined early in this decade by Thomas Lindhqvist to describe a policy then emerging in Europe and now sweeping the industrialized world. Lindhqvist, a Swedish professor of environmental economics, defined EPR as the extension of the responsibility of producers for the environmental impacts of their products to the entire product life cycle, and especially for their take-back, recycling, and disposal. In practice, the term has mostly been used to describe producer responsibility “post-consumer” - after products have been discarded at the end of their useful life. As such, EPR shifts the responsibility for discarded materials that would otherwise be managed by local government to private industry, thereby incorporating the costs of product disposal or recycling into product price. First mandated in Germany in 1991, EPR policies are now spreading around the world and are the focus of heated policy debate. A concept called "EPR" also exists in this country, but with some marked substantive differences. In 1996, the President's Council on Sustainable Development recommended an EPR policy of "extended *product* responsibility," which it defined much more broadly as the shared responsibility of government, consumers, and all industry actors in the product chain for all the environmental impacts of a product over its life cycle, with no emphasis on the producer's unique responsibilities or on the post-consumer stage. This article describes the origins of EPR, the key issues involved in its implementation, and the direction in which it may now be headed. Unless otherwise noted, EPR refers throughout to extended *producer* responsibility. The term "waste" is used in the vernacular sense to refer to products discarded by consumers; it is not meant in the legal sense to distinguish waste materials from usable materials or products.

Eric Marks[6] discussed the case of Dell Computers. Dell has recalled 4.1 million notebook computer batteries made by Sony Corp. due to overheating and fire risks. This represents the largest recall in Dell's history, affecting 2.7 million notebook computers in the United States. And it isn't just a record for Dell; the recall is the largest in the history of the consumer electronics industry. For its part, Apple issued a recall for 1.8 million iBook and PowerBook laptop batteries, also made by Sony Corp. The recalls expose an aspect of the supply chain that has gained prominence in recent years: reverse logistics. Reverse logistics is the product distribution process traced backward - from the consumer to the manufacturer. It involves processing product returns because of damage, recalls, excess inventory, end of life, and other factors. In addition, it not only involves products but the packaging of those products as well. The cost of reverse logistics equals about half of one percent of the U.S. gross domestic product. Think big here. In 2004 this amounted to roughly $58 billion. Reverse logistics is increasingly becoming part of a total product and customer experience model, especially in the consumer-electronics-driven economy we live in. Bette Fishbein[6] presented a case study looking 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 waste stream 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 waste stream in other ways by:

- Redesigning batteries to reduce or eliminate the toxic constituents;
- Substituting batteries with less toxic constituents; and
- 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. Carola Hanisch[7] presented a very successful nationwide EPR model in the United States—one that has not come about entirely voluntarily—involves take-back of nickel cadmium rechargeable batteries. Some states had begun to prohibit sale of such batteries unless producers agreed to take them back. Producers, not wanting to deal with a multitude of varying legislation in different states, initiated a nationwide take-back system. A broader definition of EPR has gained acceptance. Here, EPR stands for "Extended *Product* Responsibility". It is based on the principle that all 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 products, impacts from manufacturers' production processes, and downstream impacts from use and disposal of products. Not everyone is satisfied with this U.S. definition of EPR. "I agree, we have to look at the whole life cycle of products. But, for example, if you buy a pen you have very little influence on how to design a pen that is nontoxic or recyclable. How often in your life have you contacted manufacturers to tell them to change the design of their pens? Nobody does that. So by having an extended *producer* responsibility, you are putting some pressure on producers to change their production designs". Olaf Schatteman[8] covered the basic concept of Reverse logistics is explained and its commercial importance in the US economy, about 4% of the total logistics cost of USA which was $ 35 billion in 2001. In 2001 the average customer return across retailer was 6 % . He investigated Under what all scenarios does reverse logistics occurs? How could this concept could be used as an attacking weapon in the war of success by the companies? He suggested four basics steps which are followed in implementing reverse logistics.

Edward .J. Marien[9] stated that as more and more industries are discovering that it pays to be proactive on environmental issues—as opposed to passively waiting to be regulated into action. They've found that it makes good business sense to recycle and reuse their products after the consumer is done with them. This article examines the power and potential of "reverse logistics" in a competitive context. It spotlights the efforts of the paint industry, which while facing difficult challenges has recorded some early successes. One central lesson learned from this article was that for source reduction to achieve optimum competitive advantage, cross-functional inter company reverse business systems need to be in place. These reverse business systems must embrace such areas as remanufacturing operations, marketing and pricing, accounting and finance, and inventory management as well as the reverse transportation and logistics functions. Margarete Seitz[10] stressed on the fact that in a product recovery environment, the process of transporting, handling and returning of used products from the (end-) customer to a processing facility plays a major role. Reverse logistics is often seen as the most complex activity within product recovery management, as products have to be collected and delivered from many locations (end-users) to one processor (recovery plant). Remanufacturing is just one of many recovery options. However, in comparison to others, for example recycling, it offers the transformation of end-of-life products and components into products with an 'as good as new' condition through machining, rewinding, refinishing or similar operations. It further differs from repairing, reusing, and reconditioning, due to the fact that remanufacturing also recovers the value originally added to the raw material. Hence this type of recovery makes a much greater economic contribution per unit of product compared to recycling. Remanufacturing is therefore often called 'the ultimate form of recycling'.

Harold Krikke[11] deals with the use of mathematical optimization ( Operations Research) models in logistics, in view of new developments in reverse logistics on the one hand and chain logistics on the other hand. The mathematical model can be programmed in a computer and after data is entered the computer optimizes the problem and gives numerical results. Originally developed in the Military, Operations Research (OR) has developed into a full management discipline, with many applications. Reverse logistics is a (re-)new(ed) area in logistics concerning the logistics of take back and recovery of discarded packages and products. *Renewed*, because recycling in itself is nothing new and has been applied for centuries. *New*, because the driving forces and responsibilities are different. In the old days economic motives were dominant and only valuable waste was recycled, while nowadays environmental concern is the driving force. Moreover, recycling was traditionally the domain of small scale specialized firms, where now Original Equipment Manufacturers (OEMs) are held responsible for proper take back- and recovery systems. This is often referred to as *extended producer responsibility.* In Europe, new political policies aim at the closure of material flows. Marisa P. de Brito and Rommert Dekker[12] said that Reverse Logistics has been stretching out worldwide, involving all the layers of supply chains in various industry sectors. While some actors in the chain have been forced to take products back, others have pro-actively done so, attracted by the value in used products One way or the other, Reverse Logistics has become a key competence in modern supply chains. In this paper, he has presented a content analysis of reverse logistics issues. To do so, he proposed a content framework focusing on the following questions with respect to reverse logistics: why? what? how?; and, who?, i.e. driving forces and return reasons, what type of products are streaming back, how are they being recovered, and who is executing and managing the various operations. These four basic characteristics are interrelated and their combination determines to a large extent the type of issues arising from the resulting reverse logistics system.

**Research Design**

*1. Type of study*

The entire study has been carried out in two phases:

A. *Exploratory:* it aims at examining the secondary data for analyzing the previous researches that have been done in the arena of reverse supply chain in battery industry. The knowledge thus gained from this preliminary study forms the basis for the further detailed descriptive research. It helped in under standing this concept and how really it is being implemented.

B. *Descriptive:* the study has been carried out wherein various companies were covered in India which were following this practice of reverse supply chain in organizations in battery business in India .the various sectors which they are in and how well are they implementing this and does it add any value to their company by following such practices.

*2. Instruments*

The instruments that have been used are:

Qualitative structured interview and focused group discussion.

*3. Analysis*

In-depth Study of the Forces of Continuity and Change in Reverse Supply Chain of Battery Industry in India and developed countries

As a part of this research we have studied the key underlying aspects of reverse supply chain management by examining the following basic questions using a structured questionnaire and taking opinions of leading experts in this field. Key research questions are :

1. *Why are things returned:* we go over the driving forces behind companies and institutions to become active in Reverse Logistics, Why drivers (receiver), and the reasons for reverse flows (return reasons), i.e. Why reasons (sender);
2. *What is being returned:* we describe product characteristics which makes recovery attractive

or compulsory and give examples based on real cases (products and materials);

3. *How Reverse Logistics works in practice:* we give a list of processes carried out in reverse logistic systems and we focus on how value is recovered in the reverse chain (recovery options);
4. *Who is executing reverse logistic activities:* we go over the actors and their role in implementing reverse logistics (reverse chain actors);

Based on the above research the following facts emerged.

*1. Why drivers (receiver): Driving forces behind Reverse Logistics*

Generally, companies get involved with Reverse Logistics either

1. Because they can profit from it
2. Because they have to
3. Because they "feel" socially motivated to do it

Accordingly, we have categorized the driving forces of Change under three main heads :

1. **Economic Forces** (direct and indirect);
2. **Legislation**
3. **Corporate citizenship**

**1. Economic Forces:** A reverse logistics program can bring direct gains to companies from dwindling on the use of raw materials, from adding value with recovery, or from reducing disposal costs. Others have also gone into the area because of the financial opportunities offered in the dispersed market of superfluous or discarded goods and materials. Metal scrap brokers have made fortunes by collecting metal scrap and offering it to steel works, which could reduce their production costs by mingling metal scrap with virgin materials in their process. In the electronic industry, many products arrive at the end of useful life in a short period, but still with its components having intrinsic economic value. *ReCellular* is a U.S. firm that has showed to know how to take economic advantage from this as of the beginning of the nineties by trading in refurbished cell phones. Even with no clear or immediate expected profit, an organization can get (more) involved with Reverse Logistics because of marketing, competition and/or strategic issues, from which are expected indirect gains. For instance, companies may get involved with recovery as a strategic step to get prepared for future legislation or even to prevent legislation. In face of competition, a company may engage in recovery to prevent other companies from getting their technology, or from preventing them to enter the market. According to Dijkhuizen (1997), one of the motives of *IBM* in getting involved in parts recovery was to avoid that brokers would do that. Recovery can also be part of an image buildup operation. For instance, *Canon* has linked the copier recycling and cartridge recycling programs to the "kyosei" philosophy, i.e. cooperative growth, proclaiming that Canon is for "living and working together for the common good". Recovery can also be used to improve customer's or supplier' relations An example is a tyre producer who also offers customers rethreading options in order to reduce customer's costs. To summerise, the economic driver embraces among others, the following direct and indirect gains:

*Direct Gains*

- Input materials
- Cost reduction

- Value added recovery

*Indirect gains*

- Anticipating or impeding legislation
- Market protection
- Green image
- Improved customer or supplier relations

**2. Legislation:** Legislation refers here to any jurisdiction indicating that a company should recover its products or accept them back. As mentioned before, in many countries home shoppers are legally entitled to return the ordered merchandize. Furthermore, and especially in Europe there has been an increase of environmental related legislation, like on recycling quotas, packaging regulation and manufacturing take back responsibility. The automobile industry and industries of electrical and electronic equipment are under special legal pressure. Sometimes companies participate "voluntarily" in covenants, either to deal with (or get prepared for) legislation.

**3. Corporate citizenship:** Corporate citizenship concerns a set of values or principles that in this case impel a company or an organization to become responsibly engaged with reverse logistics. For instance, the concern of Paul Farrow, the founder of Walden Paddlers, Inc., with "the velocity at which consumer products travel through the market to the landfill", pushed him to an innovative project of a 100 percent - recyclable kayak. Nowadays indeed many firms, like Shell, have extensive programs on responsible corporate citizenship where both social and environmental issues become the priorities.

These forces are not mutually exclusive motivations and in reality it is sometimes hard to set the boundary. In many countries, customers have the right to return products purchased via a distant seller as mail order companies or e-retailers. Thus, these companies are legally obliged to give the customer the opportunity to send back merchandize. At the same time, this opportunity is also perceived as a form to attract customers, bringing potential benefits to the company.

**Why? Reasons for Return by Sender in Reverse Supply Chain**

Generally, products are returned or discarded because either they do not function properly or because they or their function are no longer needed.

We can list them according to the usual supply chain hierarchy

- Manufacturing Returns
- Distribution Returns
- Customer Returns

Now, we differentiate between manufacturing returns, distribution returns and customer returns.

*Manufacturing returns* is defined as all those cases where components or products have to be recovered in the production phase. This occurs for a variety of reasons:

Raw materials may be left over, intermediate or final products may fail quality checks and have to be reworked and products may be left over during production, or byproducts may result from production. Raw material surplus and production leftovers represent the product not - needed category, while quality control returns fit in the "faulty" category. In sum, manufacturing returns include:

- Raw material surplus
- Quality control returns
- Production leftovers or byproducts

*Distribution returns* refers to all those returns that are initiated during the distribution phase. It refers to product recalls, commercial returns, stock adjustments and functional returns. Product recalls are products recollected because of safety or health problems with the products, and the manufacturer or a supplier usually initiates them. B2B commercial returns are all those returns where a retailer has a contractual option to return products to the supplier. This can refer to wrong or damaged deliveries, to products with a too short remaining shelf life or to unsold products that retailers or distributors return to the wholesaler or manufacturer. The latter include outdated products, i.e. those products whose shelf life has been too long (e.g. pharmaceuticals and food) and may no longer be sold. Stock adjustments take place when an actor in the chain redistributes stocks, for instance between warehouses or shops, e.g. in case of seasonal products. Finally, functional returns concern all the products which inherent function makes them going back and forward in the chain. An obvious example is the one of distribution carriers as pallets: their function is to carry other products and they can serve this purpose several times. Other examples are crates, containers and packaging. Summarizing, distribution returns comprehend:

- Product recalls
- B2B commercial returns
- Stock adjustments
- Functional returns

Customer Returns are those returns initiated once the product has at least reached the final customer. Again there is a variety of reasons to return the products, viz.

- B2C commercial returns (reimbursement guarantees)
- Warranty returns
- Service returns (repairs, spare parts)
- End-of-use returns
- End-of-life returns

**What is being returned?**

A third viewpoint on Reverse Logistics can be obtained by considering what is actually being discarded or returned. Three product characteristics seem to be relevant , viz.

- composition
- deterioration
- use pattern

*Product composition* in terms of the number of components and of materials is one of the many aspects to keep in mind while designing products for recovery. Not only the number, but also how the materials and components are put together, will affect the easiness of reprocessing them. The presence of hazardous materials is also of prime relevance, as it demands special treatment. The material heterogeneity of the product can play a role in recovery, where one tries to obtain separate streams of different materials, which are as pure as possible (a problem in case of plastics). Summing up, the intrinsic characteristics of a product are decisive for the recovery. Next there are the deterioration characteristics, which eventually cause a nonfunctioning of the product, but also determine whether there is enough functionality left to make a further use of the product, either as a whole or as parts. This strongly effects the recovery option. Several questions have to be asked in order to evaluate the recovery potential of a product: does the product age during use? (intrinsic deterioration); do all parts age equally, or not? (homogeneity of deterioration); does the value of the product decline fast? (economic deterioration). In fact, products may become obsolete because their functionality becomes outdated due to the introduction of new products in the market, as happens with computers. This will restrict the recovery options that are viable. The same can be said for the intrinsic deterioration and whether, or not, it is homogeneous. If a product is consumed totally during use, such as gasoline, or if it ages fast, like a battery, or if some parts are very sensitive to deterioration, reuse of the product as such is out of the question. If however, only a part of the product deteriorates, then other recovery options like repair or part replacement or retrieval may be considered. The product use pattern, with respect to location, intensity, and duration of use, is an important group of characteristics as it affects for instance the collection phase. It will make a difference whether the end-user is an individual or an institution (bulk use), demanding different locations for collection or different degrees of effort from the end-user (e.g. bring to a collection point). The use can also be less or more intensive. Let us consider the case of leased medical equipment, which is commonly used for a small time period, and it is likely to be leased again (after proper operations like sterilization). Time is not the only component describing intensity of use, but also the degree of consumption during of use. Consider for instance the example of reading a book. Quite often one reads a book only once after the purchase and keeps it, but does not do anything with it later on. This has stimulated Amazon to start her successful secondhand trading of books.

- Consumer goods (apparel, furniture, and a vast variety of goods)
- Industrial goods (e.g. military and professional equipment)
- Spare parts
- Packaging and distribution items
- Civil objects (buildings, dikes, bridges, roads, etc.)
- Ores, oils and chemicals
- Other materials (like pulp, glass and scraps)

**How Reverse Supply Chain Processes work?**

How Reverse Logistics works in practice: how is value recovered from products. Recovery is actually only one of the activities involved in the whole reverse logistics process. First there is collection, next there is the combined inspection / selection /sorting process, thirdly there is recovery (which may be direct or it may involve a form of reprocessing), and finally there is redistribution. Collection refers to bringing the products from the customer to a point of recovery. At this point the products are inspected, i.e. their quality is assessed and a decision is made on the type of recovery. Products can then be sorted and routed according to the recovery that follows. If the quality is (close to) “as good as new,” products can be fed in the market almost immediately through reuse, resale and redistribution. If not, another type of recovery may be involved but now demanding more action, i.e. a form of reprocessing. Reprocessing can occur at different levels: product level (repair), module level (refurbishing), component level (remanufacturing), selective part level (retrieval), material level (recycling), energy level (incineration). For other points of view on recovery/reprocessing levels, at module level, the product, e.g. a large installation, building or other civil object gets upgraded (refurbishment). In case of component recovery, products are dismantled and used and new parts can be used either in the manufacturing of the same products or of different products (remanufacturing). In material recovery, products are grinded and their materials are sorted out and grouped according to a quality wish, so recycled materials can be input raw material, such as paper pulp and glass. Finally, in energy recovery products are burned and the released energy is captured (incineration). If none of these recovery processes occur, products are likely to go to landfill. Recovery options ordered as for the level of reprocess required, in a form of an inverted pyramid. At the top of the pyramid, we have the global levels, such as product and module, and at the bottom more specific levels like materials and energy. Please note that returns in any stage of the supply chain (manufacturing, distribution and customer) can be recovered according to options both from the top and from the bottom of the pyramid. At first, one may think that recovery options at the top of the pyramid are of high value and more environmentally friendly than options close to the bottom, which recover less value from the products. We would like to stress that both thoughts are not necessarily true. Originally, the Lansink's hierarchy was put together regarding the environmental friendliness of the recovery option. Yet, the hierarchy is disputable even there. In the case of paper recycling versus land filling, one may go against recycling by arguing that paper is biodegradable and requires less energy than the de-inking and bleaching processes necessary for recycling. With respect to the economic value of each recovery option, that depends for instance on the existence of a matching market. Thus, it is possible that a used product has essentially no market value as such, but is very valuable as a collection of spare parts.

**Partners in Reverse Supply Chain**

There are several viewpoints on partners in reverse logistics. We can make a distinction between

- Forward supply chain actors, (as supplier, manufacturer, wholesaler and retailer)
- Specialized reverse chain players (such as jobbers, recycling specialists, etc.)
- Opportunistic players (such as charity organization)

Some of the players are responsible for or they organize the reverse chain while other players simple execute tasks in the chain. The final player role we have to add to this is the accommodator role, performed by both the sender/giver and the future client, without whom recovery would not make much sense. Any party can be a sender/giver, including customers. The group of actors involved in reverse logistic activities, such as collection and processing, are independent intermediaries, specific recovery companies (e.g. jobbers), reverse logistic service providers, municipalities taking care of waste collection, public private foundations created to take care of recovery. Each actor has different objectives, e.g. a manufacturer may do recycling in order to prevent jobbers reselling his products at a lower price. The various parties may compete with each other. The parties at the top of the picture are either responsible or made responsible by legislation. They are from the forward chain, like the OEM. Next we also have parties organizing the reverse chain, which can be the same parties, or foundations in case companies work together or even the state itself. Below these parties we have the two main reverse logistic activities, collecting and processing, which again can be done by different parties.

**Reverse Supply Chain Activities**

Typical reverse supply chain activities would be the processes a company uses to collect used, damaged, unwanted (stock balancing returns), or outdated products, as well as packaging and shipping materials from the end-user or the reseller. Once a product has been returned to a company, the firm has many disposal options from which to choose. If the product can be returned to the supplier for a full refund, the firm may choose this option first. If the product has not been used, it may be resold to a different customer, or it may be sold through an outlet store. If it is not of sufficient quality to be sold through either of these options, it may be sold to a salvage company that will export the product to a foreign market. If the product cannot be sold "as is," or if the firm can significantly increase the selling price by reconditioning, refurbishing or remanufacturing the product, the firm may perform these activities before selling the product. If the firm does not perform these activities in-house, a third party firm may be contracted, or the product can be sold outright to a reconditioning / remanufacturing / refurbishing firm.I After performing these activities, the product may be sold as a reconditioned or remanufactured product, but not as new. If the product cannot be reconditioned in any way, because of its poor condition, legal implications, or environmental restrictions, the firm will try to dispose of the product for the least cost. Any valuable materials that can be reclaimed will be reclaimed, and any other recyclable materials will be removed before the remainder is finally sent to a landfill. Generally, packaging materials returned to a firm will be reused. Clearly, reusable totes and pallets will be used many times before disposal. Often, damaged totes and pallets can be refurbished and returned to use. This work may be done in-house, or using companies whose sole mission is to fix broken pallets and refurbish packaging. Once repairs can no longer be made, the reusable transport packaging must be disposed of. However, before it is sent to a landfill, all salvageable materials will be reclaimed. European firms are required by law to take back transport packaging used for their products. To reduce costs, firms attempt to reuse as much of these materials as possible, and reclaim the materials whenthey can no longer be reused.

Clearly, reverse logistics can include a wide variety of activities. These activities can be divided as follows: whether the goods in the reverse flow are coming from the end user or from another member of the distribution channel such as a retailer or distribution center; and whether the material in the reverse flow is a product or a packaging material. These two factors help to provide a basic framework for characterizing reverse logistics activities, although other important classification factors exist. Regardless of their final destination, all products in the reverse flow must be collected and sorted before being sent on to their next destinations. Where products are inserted into the reverse flow is a prime determinant in the resulting reverse logistics system. If a product enters the reverse logistics flow from a customer, it may be a defective product, or, the consumer may have claimed it was defective in order to be able to return it. The consumer may believe it to be defective even though it is really in perfect order. This category of returns is called "non-defective defectives." If the product has not yet reached the end of its useful life, the consumer may have returned the product for service, or due to a manufacturer recall. If the product has reached the end of its useful life, the customer may, in some cases, return the product to the manufacturer so the manufacturer can dispose of the product properly, or reclaim materials. If a supply chain partner returns a product, it is because the firm has excess product due to an over-ordered marketing promotion, or because the product failed to sell as well as desired. Also, the product may have come to the end of its life, or to the end of its regular selling season. Finally, the product may have been damaged in transit. Majority of reverse logistics activities are related to the products only, and not to packaging. However companies are waking up to this fact and are ensuring the re-usability of packaging material. Nokia is a global example of this.

**Steps involved in Reverse Supply Chain**

Reverse Logistics involves 4 major steps, which are:

a. Local Screening

b. Collection

c. Sorting

d. Disposition/Disposal

**a. Local screening** is done at the point of collection of the returned products. Often products enter the supply chain that should not enter in the first place and cause unnecessary transportation, administration and handling costs. In an ideal reverse supply chain, products are screened at the point of collection according to specifications of the manufacturer. Disposition, however, changes based on the product (or its version), the vendor and the retailer. Therefore, complex decision mechanisms need to be maintained to allow disposition of product based on customer agreement on a product-by-product basis. With the ubiquitous presence of the Internet plenty of opportunities exist to do this in a cost efficient and effective way. A good example of effective local screening is the process implemented by Nintendo, the video game manufacturer. Nintendo rewarded retailers financially for registering the product and name of the purchaser at the time of sale. This allowed the retailer and Nintendo to determine when the warranty of a product had expired and also whether the product was returned within the allotted time window. To facilitate this process, Nintendo designed special packaging with a see-through opening for retailers to scan the product serial number when the product was sold. Another example of innovative local screening is a global copier manufacturer in Europe. It provided its field service technicians throughout Europe with a scanner connected to a handheld device, which determined if technicians had to return their defective spare parts to a central location in Europe for repair or refurbishment or whether they could dispose of the parts locally. On top of the system they worked with colored stickers that indicated the destination of the part to facilitate processing. They were able to reduce half the amount of parts returned through the system, which resulted in significant transport savings. There are many different ways to collect the products that are destined to enter the reverse supply chain. Retailers often have to send their return products back to their suppliers' different warehouses throughout the country. Different processes need to be set up to facilitate timely processing of these returns. This can often be very complicated and confusing for both retailers and manufacturers as they are dealing with multiple parties, many of whom are concentrating on getting products out to the customer, rather then back to the source. Many companies have trouble running a logistics system in forward, let alone running one in reverse in parallel at the same time. Some companies have set up central collection centers for collecting and sorting returns, which have proven to be very effective.

Ford in the US, for example, is now using one single carrier to handle all its returned spare parts. Simultaneously, it has provided the dealers with one single 800 number for all their issues with returned parts. Subaru of America has gone one step further: it has outsourced the entire returns collection to Roadway Express' reverse logistics subsidiary, Rexsis. The dealers call one toll-free number regardless of the issue and Roadway Express handles all inquiries.

**b. Sorting**

Some large retailers have been using centralized return centers (CRCs) for many years. They have selected centralized return centers dedicated to handle their entire reverse logistics operations. The advantages of using centralized return centers are numerous. When a company dedicates an entire facility, organization and system to optimize the handling of returns, benefits arise from a whole range of areas. Some of the key benefits are: efficiency can increase as employees occupy positions full-time and can focus on handling returns only, experience in the sorting process will help employees make better and quicker disposition decisions, and cycle times will improve, resulting in better asset recovery and higher customer satisfaction. GM in the US, for example, has in cooperation with UPS centralized its parts return center. Dealers once returned parts to some 200 locations, which was very confusing. Today all returned parts – 30 000 a month – go to the Orion facility. In any case, whether it happens in a centralized way or not, sorting is a crucial step in the reverse logistics process because employees make decisions on what ultimately happens to the returned product. Complex business rules underlying these decisions need to be updated continuously and designed so that employees can implement the rules easily. Use of bar code scanners connected to a database that contains those business rules speeds up the process and avoids judgmental errors. Information technology is a key in this process and will be discussed in more detail later. In the near future use of radio frequency (RF) tags can automate this process even further. RF tags are already used on expensive products, however their current price does not yet allow them to be applied to mass consumer goods.

**c. Disposition/Disposal**

Three ways to dispose of product can be distinguished: sell as-is, repair or reuse (part of it) and ultimately dispose of the product. Some key activities within each of these categories are: Sell as-is:

- resale (as new)
- sell via outlet or discount store
- e-auction, and
- sell to secondary market

**Repair or reuse:**

- repair
- refurbish or remanufacture
- modify and
- recycle
- Dispose:
- scrap
- donate (to charity), and
- dispose in secure manner (for example, certain drugs).

Disposition should be done to maximize the value of reclaimed goods or dispose of the goods in the most cost-effective way. Below are some innovative ways leading practice companies have adopted to improve the disposition of their returned items.

**Case Study of Reverse Supply Chain Practices In The Battery Industry**

**I. Lead Acid Batteries**

**1. 1Exide Ltd., India**

Exide Batteries are one of the implementers of reverse logistics in India. Based on personal interview of many senior executives of the company in Sales & Distribution following were the findings practices were mapped. The same forward logistics path is used for reverse logistics. When an existing customer comes with an old battery of Exide, the retailer takes that battery in exchange of money or discount on the new battery. The old batteries are sent back to the factory through the wholesaler and distributor. This is a part of the Collections process. At the factory Sorting takes place. Here, the battery is checked for refurbishing or recycle. The Disposing process is broken into the following steps:

a. The plastic parts of the battery are recycled to manufacture new cases and lids.

b. Lead oxide ingots are reused by melting and then new grids are manufactured.

c. Sodium Sulphate present in the old battery acid can be used in manufacture of glass, textile, and detergents.

**Dixon Batteries, South Africa**

Dixon batteries has a proud record of 45 years in the industry. Founded by Edward Leslie (Les) Dixon, the company produced it's first batteries in 1955 in a small shop in Leslie Street, Vereeniging. Battery Recycling Batteries are amongst a handful of battery manufactures in the world whom are capable of successfully recycling the complete battery. It is our companies environmental responsibility to recycle batteries efficiently and by doing so we are contributing towards a greener South Africa by ensuring that with each new automotive battery produced by Dixon, one used battery has been removed from the environment. Recycled material processed within our plant enables us to keep consistent quality control on our raw materials, and removes a potentially hazardous waste product from the environment.

**Recycling process at Dixon Batteries, USA**

***Environmental Leading the Way, Getting the Lead Out***

Nearly 70% of all the lead produced is used to make lead acid batteries? Spent lead acid batteries are categorized as hazardous waste due to their corrosiveness, reactivity, and toxicity. Consequently, the lead acid battery industry has built up a strong infrastructure to ensure that as many of these batteries as possible are recovered and recycled. In the U.S. alone, over 90% of lead acid batteries are recycled. Lead acid batteries are subject to corrosion and sulfation that shorten their useful lives, requiring more batteries to be produced and subsequently recycled. Firefly Energy's patented carbon-graphite foam plate technology presents a number of environmental advantages. First, they replace the heavy, corrosion-prone lead grids, which comprise up to 70% of a typical lead acid battery's weight, with a non-toxic material. Therefore, there's less lead to recycle at the end of life. Secondly, this lightweight foam is porous, and it provides more surface area for the energy-generating chemistry to occur. This means that less lead chemistry is needed than in a typical lead acid battery, leading to less lead recycled at end of life. Thirdly, because the positive lead metal grids corrode and the negative metal grids sulfate, life is shortened in a typical lead acid battery. The Firefly foam is much more resilient against these two common failure modes. Longer life means a lower volume of batteries recycled. Finally, the technology developed by Firefly Energy reduces both human exposure risk and hazardous waste generation. Batteries containing Firefly's technology can be recycled through the existing lead acid recycling infrastructure. Other "advanced technology" battery alternatives, such as nickel metal hydride and lithium ion, do not have any recycling infrastructure. In fact, the battery's owner must actually pay the recycler to take the battery! Carbon is already used to increase the temperature for the smelting of lead. Firefly's carbon-graphite foam plate material is simply burned away – and actually is a net fuel for increasing smelting temperatures - and the remaining lead in the battery is recycled.

**Narada Batteries, Eu**

More than 95 percent of all of the lead and plastic from old batteries is recycled. When one buys a new battery, most states require them to return old battery. If one any old batteries in storage, he has to take these to a battery retailer for recycling. Trash collectors won't take them because it's illegal to put old batteries into landfills. The batteries should be dealt by professional recycling plant. Spent or dead batteries are broken apart, and the lead, plastic and acid are separated. The lead is melted, poured into ingots and delivered to battery plants to be used in new batteries. The plastic is chipped, washed and delivered to a plastics plant, where it is melted and made into new battery cases and other parts. Sulfuric acid can be treated in two ways. One way is to neutralize, purify, test and release it as clean water. The other method treats the acid and converts it to sodium sulfate, a product used in fertilizer, dyes and other products. Recycling doesn't just protect the environment. It reclaims valuable lead and plastic for manufacturing and saves energy and money on raw materials.

**Willard Batteries, South Africa**

"Every scrap battery returned when purchasing a Willard Battery will result in funds being generated for the planting of indigenous trees in community areas. Food and Trees for Africa will use the funds in the various projects they run around the country." The last couple of years have seen a huge amount of people relocating from rural to urban areas. This is due largely to perceived job opportunities in and around major cities. The result of this heavy influx has been the formation of large informal settlements with little or no town planning. Use of space is poor and is characterized by an ever decreasing quality in the land, the water and the air. The environmental and social consequences of rapid urbanization on our environment cannot be ignored. Hence the birth of Food and Trees for Africa who recognize that environmentally sound urban development must include Urban Greening. This is a comprehensive term used to describe all urban vegetation management (green spaces or urban vegetated areas) including urban agriculture / Perm culture and Urban Forestry. Urban Forestry is the planning and management of trees, forests and related vegetation to create, or add value to, the local community in an urban area. Through urban greening areas are not only aesthetically enhanced, they also contribute to the quality of the air, the reduction of global warming and carbon dioxide, contributing eventually to civic pride and a sense of community. Urban greening forms the essence of sustainable urban development and Willard Batteries is proud to be involved in a project of this nature which promises to reap untold rewards for future generations of urban dwellers.

How Willard Batteries recycles toxic lead-acid batteries into life affirming indigenous trees? Few people might be aware of one of the most exceptional environmental success stories of our time - the recycling of the leadacid battery. In the USA for instance lead-acid batteries top the list of the most highly recycled consumer products at 93% compared to the 42% of newspapers, 55% of aluminium soft drink and beer cans, and 40% of plastic soft drink bottles.

This success story is due, in part, to the closed loop life cycle of the lead-acid battery which is 98% recyclable**.** The recycling of lead acid batteries is very worthwhile with up to

98% of a scrap battery being recoverable, says Murray Long of Autotech. In fact the random dumping of scrap batteries is nonsensical and we plan to inform consumers that their scrap battery will be transformed into a very worthy long-term community benefit if they exchange it for a new Willard Battery. The long term community benefit to which Long refers, involves the creation of funds for Food and Trees for Africa for the numerous urban greening projects they are promoting around the country. The recycling of lead-acid batteries is a multi part process, the basics of which run as follows: Initially the battery is broken apart in a hammer mill. The broken pieces go into a vat or flotation pond where the lead and heavy materials sink to the bottom while the plastic remains afloat. At this stage of the process the polypropylene pieces are scooped away and the liquids are drawn off leaving the lead and heavy metals behind. The polypropylene, or plastic pieces are washed, air dried and then melted together into an almost liquid state. The molten plastic is then put through an extruder that produces small uniform plastic pellets. These pellets are then used to manufacture new battery cases. The lead grids, lead oxide and other lead parts are cleaned and melted together in a smelting furnace along with additives used to help in the removal of impurities. The molten lead is poured into ingot moulds. After a couple of minutes, the impurities, or dross, float to the top of the still molten lead in the moulds and is scraped away. The ingots are then left to cool. Once they have cooled they are removed and are then ready to be resmelted to produce new lead plates and other parts for new batteries. Old battery acid is handled in two ways. The one way is to neutralize the acid with an industrial compound similar to household baking soda. This turns the acid into water which is treated, cleaned and tested to ensure that it meets clean water standards. It is then released into the public sewerage system. The second way of treating old battery acid is to process it and convert it into sodium sulfate, an odorless white powder used in laundry detergent, glass and textile manufacturing. Thus a potentially noxious substance is transformed into a useful reusable product.

## II. Ni-Cd and Li ion Batteries

### *1. Dell's Recycling Program (U.S)*

Dell's recycling program for U.S. consumers includes home pick-up of used Dell-branded computers and peripheral equipment at nocharge. The service is not tied to a replacement purchase. Consumers entering a product identification number online will receive a pre-paid shipping label and an opportunity to schedule home pick-up for shipping the used computer. For more than two years, Dell has also offered consumers no-charge recycling of any brand of used computer or printer with the purchase of a new Dell computer or printer. For donating working computers, Dell's longstanding relationship with the National Cristina Foundation provides customers options that support local non-profit organizations.

Dell recognizes our responsibility to recycle the products we make and sell and we have long been committed to making the product retirement process as easy as the product purchase process for our customers. That is why we offer a number of easy and affordable recycling options for both consumers and businesses. As an example, Dell is the first in our industry to provide consumers nocharge recycling of any Dell-branded product, regardless of if they are purchasing a replacement product. Dell also recognizes that educating customers that "no computer should go to waste" is key to the success of any recycling program, and we have in place a number of consumer and business education programs.

Batteries are necessary in most computer products. Nickel Metal Hydride (Ni-MH) and Lithium Ion (Li-ion) rechargeable batteries, typically found in portable computers, can be recycled. The Ni-MH and Li-ion batteries found in Dell portables are long-life batteries, and in some cases one may never need to replace a battery. Dell also uses Lithium coin cell batteries on motherboards. In addition, depending on your system and its options, your system may include circuit boards or other components that contain batteries. These batteries should also be disposed of properly. Among the many alternatives that may be available to a cusrtomer, here are some options one might consider for recycling batteries:

- "Dell will recycle your battery through the Recycle option.
- Most municipalities have household hazardous waste facilities or
- Battery collection points to handle battery disposal and/or
- Recycling. Contact your local waste disposal agency for the address of the nearest battery deposit site.
- To find electronics recyclers by state, go to www.eiae.org." .

Dell employees are challenged through our BPI process to identify solutions to reduce waste and increase recycling. In addition, office-based employees recycle paper, copier toner, printer ink cartridges, and other items. In addition, Dell work with on-site services contractors to promote recycling of their own materials such as scrap metals, wood and oil. Dell states it recycles in accordance with EPA guidelines.

**Meeting the Requirement of EPA Legislation in US**

The U.S. Environmental Protection Agency (EPA) is the implementation and enforcement arm for Congress' environmental legislation. The Solid Waste Disposal Act, and subsequently the Resource Conservation and Recovery Act, define and describe the legal requirements, policies and guidelines for the proper management of solid waste. Dell incorporates into its contracts with its recycling suppliers language that references environmental legislation and requires suppliers comply with all applicable local, state, federal, regional, or country environmental laws, regulations or requirements of any kind related to the proper management of material.

**Nokia's Reverse Supply Chain**

The symbiotic relationship that exists between the people and nature is evident everywhere in Finland. This strong respect and appreciation for the environment appears in Finnish food, art, and literature and is a defining aspect of the culture. As a Finnish company, these traditions have permeated into Nokia's culture and work ethic, impacting all aspects of how they do business globally. Given the expansive growth of mobile communications, it is important for them to minimize the global environmental impact. Through better product design, closer control of production processes, and greater material reuse and recycling, Nokia incorporates environmentally conscious planning into its overall framework. Their aim is to be an environmental leader in environmental performance. Identification and elimination of risks and strong financial performance, while maintaining and enhancing stakeholder acceptance, are key concerns here at Nokia. Their environmental efforts are linked to all these concerns and stem from an overall mission to make environmental awareness and protection part of their everyday actions.

**Key Environmental Focuses are**

- Substance management
- Energy efficiency
- Take back and recycling

"The driving principles incorporate lifecycle thinking in everything we do. This ensures minimal environmental impact from start to finish, beginning with the extraction of raw materials and ending with recycling, waste treatment, and the reintroduction of recovered materials into the economic system."

**An eco-efficient approach**

The seven principles of eco-efficiency defined by the World Business Council for Sustainable Development combined with lifecycle thinking guide the development, production, and delivery of Nokia products and solutions. These seven principles are:

- Minimizing energy intensity
- Minimizing the material intensity of goods and services
- Extending product durability
- Increasing efficiency of processes
- Minimizing toxic dispersion
- Promoting recycling
- Maximizing the use of renewable resources

**Nokia' s Sustainable Products**

Nokia's environmental efforts are incorporated into every stage of the lives of their products. They take a roactive approach when considering the various areas of the environmental impact. The environmental activities are a part of their business strategy, ensuring competitiveness, product effectiveness, demand-supply market alignment, cost effectiveness, and customer satisfaction. Environmental efficiency is taken into account in all stages of product design. They focus on material efficiency, environmentally sound materials, disassembly, recycling, and other end-of-life (EoL) practices and energy consumption.

**Sustainable Practices at Nokia**

They see the environment as being everyone's responsibility. These pages talk about the environmental actions taking place throughout their production and operation process and efforts that they promote and support to their consumers. Take a look at this quick overview how the environment can be affected by virtually every step of a mobile phone's lifecycle, including production, its use, and eventual disposal.

*i. Design:*

The environmental impact of a phone begins on the drawing board. Unsustainable Design – When mobile phones are designed in an unsustainable way, it means environmental considerations are ignored by technical or aesthetic specifications in these cases,

- Products are made from non-renewable, non-recyclable materials
- The materials may have been procured from environmentally sensitive, unregulated areas where ethics play no role – such as mining raw materials in areas where biodiversity is fragile and runs the risk of being destroyed
- The phones may include potentially hazardous materials that can cause adverse health and environmental effects when not handled properly.
- Sustainable Design – Environmentally sustainable design means attention is paid to material and energy efficiency.

- Energy consumption is low, and the phones have power saving standby mode
- The materials come from sources where human and animal rights are not violated, and are procured in a way that has minimal environmental impact
- Component suppliers are carefully selected and audited based
  - o Unsustainable
  - o Sustainable on environmental requirements
- The materials do not cause environmental or health risks when used appropriately for e.g. the use of lead and mercury is prohibited
- Cover parts are marked as recyclable

*ii. Manufacture:*

Manufacturers play a key role in determining environmental impact. Unfortunately, sometimes a company chooses an environmentally unsustainable policy:

- The company's inefficient practices cause huge energy and material losses
- Waste is not separated and all ends up in landfills
- Renewable energy sources aren't used or even considered
- Factories have no purification system for air and water emissions and discharge untreated waste into the ground causing air, water and soil pollution
- In a sustainable model, manufacturers use systematic methods to continually improve environmental performance:
- Employees are trained in environmentally friendly practices
- Energy consumption is minimized
- Minimal amount of waste is generated and it is recovered and recycled
- Emissions into air are reduced
- Water consumption at production sites is low

*iii. Use*

How can one reduce environmental consequences through the use of the phone? Many consumers don't care about their environment or don't know they are harming it. One should avoid the following:

- Throwing used batteries and accessories into garbage
- Having your chargers plugged in even when not charging
- Handling the mobile carelessly, causing it to break or wear out sooner
- Using counterfeit accessories like batteries, chargers shortening the life of your phone
- Sustainable suggested actions :
  - o Unplug the charger when not in use
  - o Recycle your mobile phones packaging
  - o Return the mobile phone and accessories to recommended take back points
  - o Learn about environmental policies of companies

*iv.Take back and Recycling:*

Once the phone and accessories are out of use, what can be done with them?

Unsustainable practices: Used phones are brought to developing countries where,

- A recycling infrastructure does not exist
- Electronic waste in nature untreated, contaminating rivers and yards of local people
- Dumped electronics are dismantled manually which can cause environmental disaster

In sustainable environmental system, take-back and recycling points exist for used phones. Collected products are recycled in a responsible manner, and the material recovered can be maximized. The old mobile phones and accessories can be submitted to the designated take-back centers.

**Conclusions**

Each company studied above has clearly demonstrated the fact that they are continuously evolving flexible strategies to manage the forces of continuity and change for maintaining their market share and grow. Some of the forces can be classified as

**Continuity Forces**

1. Customer Base.
2. Infrastructure.
3. Technology.
4. Core competence.
5. Supply Chain and Distribution network.
6. Culture.
7. Performance.

**Change Force**

1. Globalization.
2. New Opportunities.
3. Competition.
4. Customer Needs.
5. Technology.
6. Mergers and Acquisitions.
7. Government policy.

It is clear from the study that the forces and continuity and change have shaped the strategy of many large corporations in battery business. Due to its toxic nature, companies are rather forced to adapt more environment friendly technologies, materials and handling practices in addition to have a clearly stated policy level intervention to have an effectively and effective Reverse Supply Chain in place.

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## Annexure I

***Benefits of investing in Reverse Supply Chain in Batteries.***

***Lead Acid Batteries***

Why Recycle Lead acid batteries? Unless we recycle the Lead acid spent batteries certain toxic components pose a potential risk to the environment and human health. However, recycling:

- Saves Natural Resources: By making products from recycled materials instead of virgin materials, we conserve land and reduce the need to mine for more minerals.
- Saves Energy: It takes less energy to make a recycled battery. In fact secondary lead bullion, for example, requires four times less energy to make than primary lead.
- Saves Clean Air and Water: In most cases, making products from recycled materials creates less air pollution and water pollution than making products from virgin materials.
- Saves Landfill Space: When the materials that you recycle go into new products, instead of landfills or incinerators, landfill space is conserved.
- Saves Money and Creates Jobs: The recycling industry and the associated processes create far more jobs than landfill sites or waste incinerators, and recycling is frequently the least expensive waste management option for cities and towns. The practices follow by Industry to recycle lead acid batteries:
- In India, Exide Batteries recycle 95% of its lead acid battery components
- There are others doing it, however, not to much effect

**For Ni-Cd batteries**

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 waste-stream 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 waste-stream in other ways by:

a. Redesigning batteries to reduce or eliminate the toxic constituents;
b. Substituting batteries with less toxic constituents;
c. Reducing the number of batteries discarded by extending battery life

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.