THE ART OF THE POSSIBLE

The Feasibility of Recycling Standards For Packaging

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EXECUTIVE SUMMARY

Why Focus on Packaging?

Throwaway packaging is not only the symbol of our national solid waste crisis, it is a leading contributor to the problem. But the findings in this report demonstrate that this situation can be changed. A detailed analysis of packaging materials and packaging design reveals that, using currently available technology, the packaging industry has the ability to reduce, reuse, and recycle its products.

Environmental and consumer groups in many states are now proposing that product packaging be either reusable, made of already recycled materials, or made of materials that achieve minimum statewide recycling rates. In Massachusetts, these standards would require that, by 1996, a package be reusable five times, or made of 50% recycled material by weight, or made primarily of materials that are being recycled at a state wide rate of 35%.

Our analysis of each major material used in packaging and of five common products demonstrates that recycling is truly, like politics, "the art of the possible." Using current technology, all that industry now lacks in order to package products in compliance with these flexible standards is the will to do so.

Materials Used to Make Packaging

Part One of the report consists of a material-by-material analysis of the primary materials used in packaging: six plastic resins, paper, glass, aluminum, and iron and steel. For each material, we assess the current state of recycling technology, the feasibility of collection and separation of used material, and issues in product design. In general, high recycling rates have already been achieved nationally by the paper, glass, aluminum, and iron and steel industries, and ongoing innovations should cause those rates to climb. In addition, the plastics industry, which for years has neglected recycling, is beginning to make major strides toward achieving more aggressive recycling goals.

> **Plastics**, with many qualities attractive to consumers, present the greatest challenge to packagers and environmentalists. Only 1% of plastics are now recycled even though 80% can be using existing technology. Some resins are environmentally superior to others: PET plastic, used primarily in soft drink bottles, is recycled at a 20% rate nationally, and at rates as high as 80% in states with bottle return laws. HDPE plastic, most commonly seen in milk jugs, also promises high collection and recycling rates.
>
> For plastic packaging to comply with recycling standards, manufacturers will have to standardize resins (because they must be recycled separately, products must be made out of fewer different resins), establish better collection systems, and incorporate recycled plastic into their products. Successful current examples of each of these measures abound.
>
> **Paper** is already being recycled nationwide at a rate of 26%,

while rates for some packaging uses are even higher (corrugated cardboard, for example, is recycled at a 52% rate). The paper industry itself has set an overall recycling goal of 40% by 1995. Many paper packaging products today also have significant recycled content. A plethora of new recycling technologies and product designs bodes well for achievement of recycling goals for paper.

Glass is recyclable, reusable, and able to incorporate very high levels of recycled content. 25-30% of container glass, the type used in packaging, is estimated to be recycled currently; the glass industry intends to achieve a 50% national recycling rate in the near future. And an increasing number of dairies, breweries and wine makers are using refillable bottles.

Aluminum, iron and steel have historically been recovered and recycled at high rates. The overall aluminum recycling rate nationally is now 35%, while aluminum cans are recycled at a rate of 60%. In 1986, the U.S. steel industry actually consumed more scrap than virgin material, and overall 66% of ferrous scrap is recycled. High scrap values drive aluminum recycling and promise to raise recycling rates for steel cans, which have been recovered at 45% rates in curbside collection programs.

Packaging Specific Products: Five Case Studies

Part Two of the report contains five case studies of "problem" products, products often held up as examples of areas in which recycling standards would be impractical. We examine current technology, the unique design considerations necessitated by each product, and the variety of options open to packagers and retailers under proposed recycling standards. In each case, simple changes in design or expanded use of recycling technology available today can guarantee effective delivery of the product with a minimal impact on the environment.

Milk can be packaged in paperboard cartons (paper will meet recycling rates), glass bottles (glass will meet recycling rates, and bottles can be reused and made of recycled glass), or HDPE plastic jugs (if reused or if HDPE achieves high recycling levels).

Shampoo is almost exclusively sold in plastic containers. These can meet recycling standards if made of single-resin plastics that meet minimum statewide recycling rates (Proctor & Gamble now uses PET bottles for some household products), or if they are made with recycled plastic (as many laundry detergent bottles now are), or if bottles are collected, cleaned, and reused.

Computer equipment is generally shipped in corrugated cardboard boxes with styrofoam cushioning material. Corrugated cardboard already meets recycling standards (recycling rate, recycled content), and styrofoam can be replaced with reusable polyethylene cushioning materials or with a wide range of innovative paper-based cushioning products.

Microwavable food is frequently cited as an excessively packaged product. These "convenience" foods are usually sold in an outer box (paperboard will meet recycling rate standards; recycled paperboard may also be available) plus a disposable plastic cooking tray. Simply eliminating the tray, which many packagers already do, would reduce packaging and avoid health threats posed by plastic leaching into foods during cooking. Trays can also be made of single-resin, recyclable plastic.

Foods wrapped in plastic can be packaged in a number of ways which comply with recycling standards. A Maine supermarket chain sells meat wrapped in PVC film but sitting on molded, recycled paperboard trays -- plastic film is almost always used in combination with another material (cardboard boxes, metal trays) that can include enough recycled content to meet recycling standards. Plastic film itself can also include recycled content, and it can be replaced for some uses by reusable containers or by environmentally preferable materials (paper, foil, cellophane [a wood fiber-based material], or newly developed "natural plastics" made of bioengineered, fully compostable natural polymers).

The measures described above, and many others, can all be employed <u>today</u> by manufacturers, packagers and recyclers. Future innovations in this rapidly advancing field will only brighten the outlook. The free market will ultimately decide which ones are cost-effective and offer the greatest consumer benefits. But the market needs to be pushed to pursue these possibilities. Mandatory recycling standards for packaging can provide that impetus without causing unacceptable disruptions in the marketplace.

INTRODUCTION

VISIONARY PRAGMATISM: SETTING RECYCLING STANDARDS FOR PACKAGING

The average American discards, directly and indirectly, an amount of waste equal in weight to the Statue of Liberty every five years (O'Leary et al., 1988). The economic, environmental and public health consequences of burying and burning these literal mountains of trash have been well documented.

The solution is obvious: we must eliminate as much waste as we can and recycle as much of the remainder as possible. The question that dogs even recycling advocates, however, is whether significant reduction and recycling is technically feasible in the near future.

We believe that it is feasible. Intensive recycling and waste reduction is, indeed, a visionary idea, but it is also a pragmatic and technologically achievable response to a problem that can no longer be literally or figuratively swept under the rug.

Changing Course

It can often be extremely difficult to imagine alternatives to the way things are. The sheer weight and presence of everyday reality can become an imposing force, closing our minds to the way things might be -- or even, for that matter, to the way they used to be.

Beer and soft drink bottlers, for example, have historically spent millions of dollars on campaigns to defeat bottle deposit laws, arguing that returning bottles would be impractical, unhealthy and expensive. These campaigns are designed to make us feel foolish for even considering the idea. And we do feel foolish -- until we recall childhood memories of collecting glass Coke bottles in wooden cases and returning them to the local store for spending money. Until we remember the milkman leaving fresh bottles of milk on the back step and collecting the empties. Until we visit relatives who survive quite well in states with bottle return laws, speak to friends who use cloth diaper services, realize that razors and diapers and bottles and packaging weren't always used just once and casually thrown away. Until we travel to Europe or Japan, where reuse and recycling are an accepted and acceptable way of life, a working example of the way things can be.

Bottle return laws were finally enacted in many states when people realized that reality is not unalterable. Things don't always have to be the way they are today. Leaping this mental hurdle -- a hurdle raised higher and higher by the public relations muscle of the businesses that profit from our throwaway society -- is the necessary first step toward making maximum recycling a reality.

Recycling Standards for Packaging

Product packaging is not only an obvious symbol of our throwaway society, it also makes up a third of municipal solid waste. Setting mandatory recycling standards for packaging would directly address one significant source of the solid waste crisis, while leveraging increased recycling and environmentally superior product design in many other areas.

As proposed in many states, recycling standards for packaging would be phased in over a number of years. To comply with the standards proposed in Massachusetts, a package would, by 1996, have to be either:

(1) reusable five or more times; or

(2) made of at least 50% recycled material by weight; or

(3) made of materials which are actually being recycled in the state at a 35% rate by 1996, and at higher rates five and ten years later.

How Recycling Standards for Packaging Would Work

The recycling standards approach intentionally avoids relying on heavy-handed government regulation. Instead, it sets clear guidelines and then lets businesses -- the free market -- figure out how best to comply with them.

One of the greatest obstacles to increased recycling is the lack of stable markets. Municipalities and businesses that collect and separate used materials for recycling need someone to sell those recyclables to; waste haulers and manufacturers interested in purchasing recycled material need to know that steady, dependable supplies of these materials will be available.

An important consequence of recycling standards for packaging would in fact be in the area of market creation. As packagers are encouraged to make more products out of recycled materials, demand for collected recyclables will increase. This will raise their market value, earning money for cities and towns that have invested in collection programs and stimulating more aggressive local recycling programs.

Another far reaching impact of recycling standards for packaging will be through the third standard described above. This standard gives manufacturers and their trade associations a direct stake in increasing the recycling of widely used materials such as paper, glass, metals and various plastic resins. They will invest in expanding the facilities needed for efficient collection and separation of recyclable materials, and will design all products with their ultimate disposal in mind, making them more easily recyclable.

The Purpose of This Report

Politics has been called "the art of the possible." That description applies equally well to recycling. This report examines the state of the art in recycling technology, collection and separation infrastructure, and product design, and reveals the many ways in which the marketplace will be able to adjust to recycling standards.

In Part One, we examine the broad categories of materials used in packaging: plastics, paper, glass and metals. We assess the recyclability of each material, the progress already made toward maximum recycling, and the potential for further advances.

In Part Two, we apply a narrower focus. Taking five commonly used consumer products, many of which are generally believed to pose problems for recycling, we examine current packaging methods and assess the potential for compliance with recycling standards.

PART ONE: MATERIALS USED IN PACKAGING CAN COMPLY WITH RECYCLING STANDARDS: A MATERIAL-BY-MATERIAL ANALYSIS

Recycling today is very comparable to computer technology: new developments are out of date almost before they can be reported, while problems that were insoluble yesterday become tomorrow's success stories. In this section, we examine the broad categories of materials commonly used in packaging -- plastics, paper, glass, metals -- in light of the latest advances in the recycling field. Our goal is not to prescribe what we think manufacturers and packagers should do to increase recycling. Rather, this section provides two things:

* a snapshot picture of the state of the art in recycling technology, materials collection, and product design; and

* an idea of the directions that the free market can take in each of those areas to achieve compliance with recycling standards for packaging.

A. MATERIALS RECYCLING: GENERAL CONSIDERATIONS

The following three factors generally govern the prospects for recycling any given material.

(1) Recycling Technology. Technologies currently exist that allow for the recycling of glass, aluminum, iron, tin, paper, plastic, and other materials (Selke, 1990). These processes are proven to work, as manufacturers have recycled their own scrap for decades. Since many of these technologies were originally designed to reprocess relatively pure industrial feedstocks of materials, a key question relating to recycling standards for packaging is whether the same types of technology can be used to process materials commonly found in municipal solid waste (MSW).

(2) Feasibility of Collection and Separation. Collecting and sorting materials is an integral part of any serious recycling effort, since recycling often depends on supplies of separated, uncontaminated materials. Materials Recycling Facilities (MRFs), which separate recyclables from mixed waste, provide one successful example of practical, cost-efficient recycling infrastructure. Whether through municipal collection programs, MRFs, deposit systems, or business recycling efforts, collection and separation infrastructure is a necessary component of maximum materials recycling.

(3) Product Design. By making products out of materials that are easily collected, separated, and reprocessed, recycling can be greatly enhanced. Often referred to as "designing for recycling," a product can be made in ways which increase its recyclability and which increase the fraction of the product containing recycled materials. In addition to selecting materials that are easily recyclable, constituents detrimental to recycling must be eliminated. Toxic substances pose threats to human health and the environment, and they can degrade machines and equipment or prohibit materials from being used for particular purposes.

Constituents that are toxic to consumers, such as heavy metals, are particularly problematic because they may prevent the use of recycled material in food packaging.

B. MATERIAL-BY-MATERIAL ANALYSIS

The materials most commonly used in packaging are examined here in light of each of the factors described above: the availability of technologies for material processing and recycling, the feasibility of collecting and sorting wastes, and product design.

PLASTICS

Background

In 1989, 29 million tons of plastic were used in the U.S., about a fourth of which were used for packaging. Plastics account for 7.3%, by weight, of the municipal waste stream, up from 1% in 1960; that figure is projected to increase to 9.8% by the year 2000 (Modern Plastics, 1990b).

Currently, all plastics taken together have a 1% recycling rate (Office of Technology Assessment, 1989), though more than 80% of plastics are technically recyclable (Watson, 1990). Although recycling rates for many types of plastics must increase significantly to meet standards for statewide recycling rates, plastic containers can comply with recycling standards if designed and collected for reuse -- a better alternative from a solid waste management and resource conservation standpoint.

When discussing plastics recycling, one must distinguish between the major types of plastic resins because they have different properties and cannot be recycled interchangeably. The six major types of plastic used in packaging will each be examined separately here.

Low Density Polyethylene (LDPE)

USES OF LDPE

LDPE is a major packaging material, used in flexible bags for dry cleaning, bread, produce, and trash, and in food storage containers and flexible lids. LDPE is also used in non-packaging applications such as pipes, conduit and plastic sheet.

Total Production 1990:	3.25 million tons
Amount used in packaging:	75% (2.44 million tons)
Breakdown of packaging uses:	
Closures	1%
Coatings	17%
Bottles	6%
Film	76%

(Source: Modern Plastics, 1991)

FEASIBILITY OF LDPE RECYCLING

Technologies exist to recycle LDPE collected from MSW or as industrial scrap. Uniglobe Kisco, Inc., has developed a system to recycle polyethylene from industrial scrap and packaging waste (Plastics World, 1990). Mobil recovers about 150,000 tons of scrap polyethylene film from small and medium-size processors (Modern Plastics, 1990b). Mobil uses about 50,000 tons of this scrap to make trash bags and sells the rest to other waste processors. Trash bags can tolerate large fractions of scrap (up to 90% for large bags and 50% for small bags that are thinner). Plastic grocery sacks are also being produced from recycled LDPE resins. Astro-Valcour, Inc., produces air-bubble cushioning packaging from recycled low-density polyethylene (Reuse Recycle, 1990).

LDPE RECYCLING RATE: APPROXIMATELY 3%

Based on industrial recycling data, approximately 3% of the LDPE produced annually is recovered (Modern Plastics, 1990a, 1990b). Industry observers estimate that an additional 100,000 tons of LDPE scrap is available for recovery.

LDPE COLLECTION INFRASTRUCTURE

Collection and separation of LDPE film stands as the single largest obstacle preventing LDPE from achieving recycling standards. For this reason, it is essential that efforts be made to improve the collection of LDPE film used in packaging. Programs to collect bags and wraps will be needed to capture this portion of the waste stream. When collection programs are available, consumers have demonstrated a willingness to recycle LDPE. Mobil, for example, in conjunction with supermarkets and other retail outlets, has recently instituted a recovery program for carryout grocery bags (Plastics Technology, 1990).

LDPE PRODUCT DESIGN

If clearly labeled to inform consumers of recyclability, collection rates for LDPE sacks and wraps could be improved. LDPE packaging can also be made of recycled material. Since much of the LDPE currently in MSW comes from packaging uses or is used as trash bags, using LDPE from packaging sources to make new bags and trash bags would contribute to higher recycling rates.

LDPE: OUTLOOK

Increased recycling and a reduction in the total amount of LDPE in the waste stream will need to occur for LDPE to meet recycling standards. Significant reduction can be accomplished by eliminating non-essential packaging uses.

Polyethylene Terephthalate (PET)

USES OF PET

The major uses of PET in packaging are for soft drink, vegetable oil, detergent, cleaner, and juice bottles. It is also used in microwave food trays and boil-in-the-bag bags. Non-packaging uses include polyester strappings and coatings for industrial, electrical, and transportation uses.

Total Production 1990:	1.07 million tons
Amount used in packaging:	57% (0.61 million tons)
Breakdown of packaging uses:	
Coatings	1%
Bottles	99%

(Source: Modern Plastics, 1991)

FEASIBILITY OF PET RECYCLING

PET recycling technology is well developed because demand for recycled PET is high. There are a number of different recovery processes. The most encouraging recycling news comes from the Food and Drug Administration (FDA), which has for the first time approved the use of recycled plastic in beverage containers, specifically Coca-Cola bottles produced by Hoechst Celanese Corp. (BNA, 1991). Recycled PET containers are chemically broken down into original molecules, then reconstructed to make new bottles. Goodyear has developed a similar process, for which PepsiCola Inc. is currently seeking FDA approval (Modern Plastics, 1989; BNA, 1991). Goodyear and Eastman are now funding research aimed at the use of recycled PET in other food and beverage packaging, with plans for a full-scale manufacturing plant to produce recycled PET polymer at a cost that is competitive with virgin materials (Reuse Recycle, 1990a).

Proctor & Gamble has also "closed the loop" (that is, recycled PET back into its original use) by making Spic 'n Span bottles out of recycled PET. John Brown Inc. has developed a state-of-the-art recycling system for PET and other plastic bottles. M.A. Industries, Inc., builds a system that cleans, processes, and grinds bottles into reclaimed plastic resin. Wellman, Inc., recycles 100 million pounds of PET to produce fiberfill, furniture, textiles, auto parts, tennis balls, electrical equipment, and polyester resins (Plastics Engineering, 1990).

PET RECYCLING RATE: 22%

PET bottles had a material recovery rate of 22.4% in 1989 (Modern Plastics, 1990b). Nearly all of the recovered PET comes from states with bottle return laws (Lamb, 1990). It is estimated, for example, that PET bottles are recycled at an 80% rate in Massachusetts (Brewer, 1989). Curbside collection programs are experiencing capture rates as high as 50% in states without bottle return laws (Plastics World, 1990).

PET COLLECTION INFRASTRUCTURE

Innovative new methods of collection are being developed to improve capture rates. Envipco operates reverse vending machines in states with bottle return laws which recover about 10,000 tons of PET annually. The machines facilitate recovery by offering a convenient, automated way to return bottles.

PET has a distinct advantage over other types of plastics during collection because it is used primarily as a single material type in soft drink and other bottles which can easily be distinguished by consumers, facilitating recycling. Thus, Coca-Cola and Pepsi are introducing refillable PET soft drink bottles that they expect to collect and refill up to 25 times (Reuse Recycle, 1990a).

PET PRODUCT DESIGN

Products can be designed to take advantage of PET's high level of recycling. For example, products packaged in plastics that have not attained acceptable recycling rates could switch to PET. Existing PET products can be modified to improve their recycling rates. For example, Heinz has replaced its seven-layer plastic bottle with a new bottle consisting of 98.5% pure PET plastic, which is easily recyclable using the current PET recycling procedures (Modern Plastics, 1990c).

PET: OUTLOOK

Because much of the PET commonly found in the waste stream is packaging waste in the form of bottles, this material is easily separated and collected for recycling, particularly in states with bottle return laws. Large waste haulers and plastic processors are expanding programs to capture these materials. Ease of collection, strong markets for recycled materials, and better collection programs will all help PET qualify as acceptable packaging under proposed recycling standards.

High Density Polyethylene (HDPE)

USES OF HDPE

HDPE is the prominent resin in the bottling industry. Colored HDPE is used in motor oil containers, detergent bottles, antifreeze and other bottles, while uncolored material is used in milk jugs, water bottles and other containers. Non-packaging uses of HDPE include plastic sheeting, pipe, and cable.

Total Production 1990:	4.25 million tons
Amount used in packaging:	50% (2.12 million tons)
Breakdown of packaging uses:	
Closures	2%
Coatings	1%
Bottles	81%
Film	15%

(Source: Modern Plastics, 1991)

FEASIBILITY OF HDPE RECYCLING

HDPE recycling is possible with existing technologies. The recycling systems developed by John Brown, Inc., and M.A. Industries, Inc. (see PET section, above) are used to recycle HDPE. Scrap HDPE from industrial sources is commonly recycled. Eaglebrook Plastics, Inc., recycles over 1.5 million pounds per month of polyethylene scrap. It has developed a technology that enables it to reclaim and recycle post-consumer HDPE bottles that are contaminated with paper labels, dirt and product residue (Stephens, 1987).

Recycled HDPE has been used mainly in low-cost, non-critical applications such as flower pots, plastic pipes, trash cans, and beverage bottle crates. But recent efforts to recycle HDPE into higher value products are meeting with success. Exxon, for example, has developed a virgin HDPE resin that is designed to accept recycled HDPE without any decrease in bottle strength, and Proctor & Gamble now uses post-consumer HDPE as a middle layer of a three-layer plastic bag for packaging its diapers (Reuse Recycle, 1990a). Proctor & Gamble is also offering laundry detergents (Downy, Tide, Cheer, Era, and Dash) in HDPE bottles which contain about 20-30% recycled HDPE from milk jugs. Sonoco Graham manufactures oil containers made from 15-25% recycled HDPE (Modern Plastics, 1990a). Texaco, Valvoline and Exxon produce oil bottles made of 50% recycled materials (Sonoco, 1990).

HDPE RECYCLING RATE: APPROXIMATELY 3%

About 2.4% of the HDPE used in packaging 1989 was recycled (Modern Plastics, 1990b), about half from milk jugs and half from soda bottle base cups. The actual rate of all HDPE recycling is somewhat higher, however, because of recycled industrial scrap.

HDPE COLLECTION INFRASTRUCTURE

Recently, industry has been adding capacity to reprocess HDPE containers, anticipating growth opportunities in the reclaimed HDPE market (Schell, 1989). Increased collection of dairy and detergent bottles by the major waste processors will provide for significant growth in HDPE recycling. Currently, demand is growing and prices are strong for reclaimed material. HDPE, like PET, is easy to collect because it is commonly used in containers that are clearly labeled and therefore easily separated by consumers.

HDPE PRODUCT DESIGN

Improvements in product design are being made to increase the recyclability of HDPE containers. Exxon Polymers will start producing a grade of HDPE resin that can accept higher levels of recycled resin without sacrificing bottle strength (C&EN, 1990b). Using in-mold labels that are part of the plastic container and replace conventional paper labels provide additional processing advantages: they eliminate the problem of washing out the paper labels and the adhesives used to attach them. Small amounts of paper that cannot be washed out eventually lead to a degradation in resin properties; their elimination allows for higher grade recycled plastics (Modern Plastics, 1989b).

HDPE: OUTLOOK

Industry efforts to improve collection of HDPE and ongoing research into methods of improving HDPE's recyclability can only result in higher recycling rates. There are no technical reasons keeping HDPE from meeting recycling standards. All that is needed is a commitment to improve overall recovery. Because HDPE is by far the largest plastic resin used in containers and it is clearly marked with recycling codes, this material can easily be separated for collection and should eventually be recycled at high rates.

Polyvinyl Chloride (PVC)

USES OF PVC

PVC in packaging is used in containers such as shampoo bottles, bottle liners, blister "bubble" packaging, and films. PVC is used in a variety of products including upholstery, sporting goods, luggage, pipes, auto parts, and many other items.

Total Production 1990:	4.65 million tons
Amount used in packaging:	8% (0.39 million tons)
Breakdown of packaging uses:	
Closures	5%
Coatings	3%
Containers	51%
Film	40%

(Source: Modern Plastics, 1991)

FEASIBILITY OF PVC RECYCLING

Plastics Recovery Systems has developed a process for cleaning and separating PVC in municipal solid waste (Plastics World, 1990). Once separated, PVC is easily reprocessed into new products. Occidental Chemical, Rohm & Haas, BF Goodrich, and European firms have been building commercial programs to recycle PVC. Oxy Chem plans to sell 75% virgin/25% recycled PVC material to processors (C&EN, 1990b). Mirrex Corp. produces transparent vinyl packaging film containing a minimum of 30% post-industrial recycled vinyl (Reuse Recycle, 1990a). Recycled PVC is used to make floor mats, pipe fittings, and non-food packaging.

Successful recycling is particularly important for PVC: when incinerated, it releases hydrochloric acid and perhaps dioxins and furans into flue gases, and contributes toxic heavy metals (from cadmium and lead additives) to fly ash particles; when landfilled, toxic plasticizers are believed to leach into soil and groundwater.

PVC RECYCLING RATE: APPROXIMATELY 1%

It is difficult to estimate recycling rates for PVC. The U.S. auto industry recycled an estimated 7,500 tons of PVC. Industry estimates that another 42,000 tons was recovered (Modern Plastics, 1990b). Based on these figures, less than one percent of PVC produced is recycled. However, since much of the PVC produced is used in durable products, it is difficult to estimate how much PVC recycling is occurring in relation to the amount disposed of.

PVC COLLECTION INFRASTRUCTURE

PVC recycling technology has focused on improved methods of separating materials. Electromagnetic techniques to identify and separate PVC bottles from PET have been developed to facilitate recovery from mixed plastic waste (Modern Plastics, 1990b). Efforts are under way by industry to collect more PVC containers from MSW.

PVC PRODUCT DESIGN

Reducing the toxicity of PVC wastes is essential to improving recycling. Efforts are focused on ways to eliminate heavy metal additives, such as lead and cadmium. Eliminating metals from PVC should eventually lead to a safer recycling environment for this material. Industry has developed non-cadmium-stabilized polyvinyl products to replace cadmium, a toxic metal that poses threats to workers, consumers, and the environment (C&EN, 1990a). The European PVC industry has already developed and is using alternatives to cadmium (Modern Plastics, 1990b).

PVC: OUTLOOK

Since much of the PVC produced is used in products such as pipes, building materials, and durable goods, much of this material does not end up in the waste stream. PVC that is commonly found in MSW comes from packaging and disposable consumer products. By continuing to develop and improve collection and separation technologies for PVC, recycling rates could increase significantly. In fact, U.S. demand for recycled plastic bottles will exceed supply by more than two to one (Reuse Recycle, 1990). Since film is approximately 42% of PVC's packaging use, the challenge is to find ways to reduce such uses and to collect PVC film used in packaging (Modern Plastics, 1990a). As is the case with LDPE, efforts will be needed to collect films and educate consumers to their recyclability.

Polystyrene (PS)

USES OF PS

PS in packaging is commonly used in carry-out food service containers, yogurt cups, tubs, muffin trays, vitamin bottles, and most fast food cutlery. Besides packaging, PS is used in housewares, electronics, and other consumer products.

Total Production 1990:	2.57 million tons
Amount used in packaging:	34% (0.87 million tons)
Breakdown of packaging uses:	
Closures	12%
Containers	75%
Film	11%

(Source: Modern Plastics, 1991)

FEASIBILITY OF PS RECYCLING

Eight chemical companies have formed the National Polystyrene Recycling Corporation (NPRC) (Watson, 1989). NPRC builds recycling plants utilizing a variety of technologies, including systems designed by Irwin Research and Development Corporation (Plastics World, 1990). The Plastics Again facility in Leominster, MA, is probably the best known PS recycling plant. Recycling plants convert PS into pellets which can be processed to make new products. Rubbermaid, the housewares supplier, for example, uses recycled PS in products such as food service trays, trash receptacles, and office accessories. Other uses include office supplies and video tape cases. Amoco uses reclaimed PS for foundation protection boards in commercial buildings (Nir, 1990).

PS RECYCLING RATE: 3%

Currently, PS recycling rates are negligible, though NPRC aims to increase PS recycling levels to 25% by 1995 (Watson, 1989).

PS COLLECTION INFRASTRUCTURE

While the technology to recycle large quantities of PS foam is available, the means and incentive to collect sufficient amounts are not well developed. Recycling programs currently collect waste generated from food service applications. The NPRC has formed programs with large waste generators, such as McDonald's, to improve collection of PS used in food service applications.

PS PRODUCT DESIGN

Rubbermaid uses modifiers to improve the quality of recycled PS allowing it to be converted into value-added products (Nir, 1990). Continued development of additives and modifiers will improve PS recycling, but the major problem confronting PS recycling is collection.

PS: OUTLOOK

For PS to meet recycling standards, collection must extend beyond limited segments of the waste stream, such as fast food containers. This could occur if NPRC is seriously devoted to meeting its aggressive recycling goals.

Polypropylene (PP)

USES OF PP

PP is used in battery cases, medical containers, oil additive containers, dairy products, cereal box liners, caps, labels, bags, lids, and other containers.

Total Production 1990:	4.07 million tons
Amount used in packaging:	18% (0.75 million tons)
Breakdown of packaging uses:	
Closures	28%
Coatings	2%
Containers	31%
Film	39%

(Source: Modern Plastics, 1991)

FEASIBILITY OF PP RECYCLING

PP is recycled industrially and some post-consumer collection has started for films and containers. A system developed by Uniglobe Kisco recycles polypropylene scrap and packaging waste (Plastics World, 1990).

PP RECYCLING RATE: LESS THAN 1%

While recycling of PP is technically feasible, the lack of collection infrastructure and a steady market for post-consumer material frustrates effective PP recycling. Currently, recycling of PP in MSW is virtually non-existent.

PP: OUTLOOK

For PP to meet proposed recycling rate standards, collection must be improved significantly and a recycling infrastructure must be created. If made with recycled material or collected for reuse, specific PP packages would comply with the other recycling standards.

Engineered and Mixed Plastics

One of the most promising recent innovations in plastic technology is in the area of engineered plastics. General Electric, for example, announced in March, 1989, the development of its trademarked LEXAN resin. GE claims that, when used for bottles, this plastic can be sterilized and refilled up to 100 times, after which it can be reground and reprocessed for use in products like automobile bumpers; ten years later, the plastic can be recovered and reprocessed into building materials. While this plastic costs more initially to produce than disposable commodity packaging, GE contends that its extended reuse would actually lower costs to the consumer and that it will be more economically feasible to ultimately recycle this resin than to dispose of it (GE, 1989).

There are other plastics used in packaging, generally mixtures of resin types. Many microwavable foods, for example, are packaged in containers containing barrier layers of mixed plastic.

While there have been innovations in mixed plastics recycling technologies, mixed plastics often pose serious problems for recycling. Advances in product design, however, may offer ways of eliminating unrecyclable mixed plastics from packaging. Heinz's conversion to a recyclable plastic ketchup bottle, from an earlier seven-layer, unrecyclable design, was mentioned earlier. Another example is the development of plastic films coated with a micro-thin layer of glass, or silica (SiO_2), which are claimed to have recyclability superior to conventional barrier films. Separation of the silica is not required since it is present in only small quantities and its mixing into the resin does not adversely affect the recycled material properties (Modern Plastics, 1990c). Innovations in product design will likely contribute to increased recycling of packaging with barrier properties.

Summary: Plastics Recycling

Plastic is unquestionably the material that presents the greatest challenge to the achievement of recycling standards for packaging. The two major packaging plastics that are recycled at present, PET and HDPE, account for almost all post-consumer plastics recycling in the country. These resin types are relatively easy to collect (mainly from soft drink bottles in states with bottle return laws and from milk jugs) and can be recycled using existing technologies for recycling clean industrial scrap. Even among such sources, however, only a very small fraction of the total has been tapped. And post-consumer recycling of other plastic resins has hardly gotten off the ground.

Recycling of the many plastics discussed above is technologically possible, and has occurred for years within the industrial production process. Post-consumer collection and recycling is also possible. Measures such as recycling standards for packaging will push manufacturers to label all plastics by resin type, to standardize the types of plastics used for particular purposes, and to design their products and packaging for ease of collection and recycling. Steps such as these, which are well within current capabilities, can help put many plastic resins on a par with other materials in terms of their recyclability.

Another issue confronting industry and environmentalists is the degradation of plastics from recycling. The more times a material can be used, recycled and used again, the better its environmental impact. Metals, for example, can be recycled and reused innumerable times, with each cycle generating energy savings, resource conservation, and pollution reduction. It is unclear how many times plastics can be recycled, although, as with every area of plastics recycling, new research is turning up more encouraging answers to this question:

* New processing technologies: InstaMelt Systems Inc., of Texas, has designed a recycling system that reduces degradation of

plastic during recycling by reducing the time it takes to process the material.

* New additives: antioxidants have been found to preserve plastics once they have been processed. An example of an antioxidant developed especially for recycling is Quantum Chemical's Spectratech RM-11575 stabilizer, which prevents breakdown of the ethylene-vinyl alcohol barrier layer during recycling of multilayer barrier packaging (Modern Plastics, 1990b). Other additives may also allow formulation for reuse (Plastics Engineering, 1989).

Mandatory recycling standards, phased in over a number of years to give manufacturers time to adapt, can be expected to stimulate more research along these and other lines.

PAPER AND PAPERBOARD

Total U.S. paper production in 1988 was estimated to be 79 million tons (API, 1990). Paper packaging material accounted for approximately 48% of the paper in MSW in 1988 (EPA, 1988). Packaging made of paper and paper products is used in bags, boxes, food trays, and a variety of wraps (OTA, 1989).

Total Paper Production:	79 million tons
Newspaper	6 million tons
Printing and writing	22 million tons
Packaging	41 million tons
Other uses	10 million tons

(Source: API, 1990)

FEASIBILITY OF PAPER RECYCLING

The paper industry has historically used waste paper to produce new products. Paper mills use a variety of de-inking technologies to prepare recycled paper for further processing (OTA, 1989).

Interest in recycling has brought the development of cheaper and more efficient recycling technologies. Advances in secondary fiber processing technology include improvements in stock preparation, which makes for higher quality recycled materials and improved runability of paper machines when using recycled fibers (Iannazzi,1990). Equipment to remove ink and chemicals has also been improved, creating higher quality recycled paper. New technologies are capable of finely dispersing inks and "sticky" contaminants. Gyroclean technology removes "stickies" and varnishes with an efficiency of 95-99% (Iannazzi, 1990). Chesapeake Corp., of Virginia, has introduced a new low-cost recycling process for the recovery of post-consumer newsprint, corrugated cardboard, and unsorted office paper in one feed stream. The system, noted for its simplicity, cuts paper recycling costs by a third by reducing the number of steps in the process from 21 to just eight (C&EN, 1991).

Recycling paper reduces the length, and thus the strength, of its fibers. Estimates suggest, though, that fibers can be recycled for reuse about eight times. Research is continuing into the development of additives that can compensate for loss of strength caused by shortened fibers.

PAPER RECYCLING RATE: 26%

The total recovery rate for paper in 1988 was 25.6%. Of the 26.2 million tons of paper recovered from MSW, 20.4 million tons were recycled by the domestic paper industry (some tonnage was lost to exports) (Iannazzi, 1990). The paper industry has set a 40% recycling goal by 1995 (API, 1990).

About 13.4 million tons of wastepaper were recycled into such packaging materials as corrugated cardboard boxes and paperboard (Pulp & Paper, 1990). Packaging material now contains about 20% post-consumer paper waste. These levels will increase as planned expansion of waste paper utilization facilities come on line. New plants able to utilize waste paper will allow the paper industry to reach its 40% goal by 1995.

PAPER COLLECTION AND RECYCLING INFRASTRUCTURE

Corrugated cardboard constitutes the largest single set of paper packaging products, with 22.9 million tons sold in 1988. About 52% of old corrugated containers were recovered (Iannazzi, 1990). Old corrugated cardboard is typically compacted and baled at industrial facilities and retail outlets for shipping to paper mills for recycling. Improved collection, especially from residential sources, could further improve cardboard recycling.

The paper industry is already taking steps to raise recycling rates by expanding waste paper utilization and promoting collection programs. Once it enters the waste stream, paper loses recycling value because it is very easily contaminated. Therefore, it is critical to separate paper from the rest of the waste stream at the outset. Since the reuse application of different paper products is a function of the fiber length, it is worthwhile to segregate waste paper based on composition (e.g., separate writing and printing papers from old corrugated containers from old newspapers). Increased education on the importance of separation combined with new programs to collect different grades of paper (such as office recycling) will improve overall paper recycling.

PAPER PRODUCT DESIGN

Improved product design which enhances the use of reclaimed materials without adversely affecting performance can help improve recycling rates. One interesting example is a new multilayering technology, which allows for a more effective use of recycled fiber (Iannazzi, 1990). This would allow paperboard and tissue to contain greater recycled content. Further advances in technologies for coatings and pigments have improved the surface finish of paper with high recycled content, allowing recycled paper to be used in value-added products (boxes, paper plates and cups) rather than lower grade uses (tissues, newsprint).

Corrugated Containers: Constructed with unbleached Kraft paperboard liners and semi-chemical paperboard corrugating material between liners, corrugated cardboard boxes already contain significant levels of recycled content. Though strength requirements of the containers generally govern the allowable amounts of recycled content, this remains a good place for even greater use of recycled paper.

Folding Cartons: These are also made from unbleached Kraft paperboard and performance requirements again limit the amount of recycled fibers. Kraft paper produced in the U.S. contains only about 10% reused materials (OTA, 1989). Because folding cartons contain high grade fibers, they should be considered valuable inputs for recycling. Efforts to recycle folding cartons into products with less demanding strength requirements will help overall paper recycling.

Coated Paperboard: This material is used mainly in food applications -- milk cartons, frozen foods, six-pack carriers, paper cups and plates -- and has traditionally not incorporated recycled materials, even though not prohibited (see the discussion of Food & Drug Administration safety requirements in Part Two, below). Also, since these products are generally coated with plastic, they have not been part of the recycling stream so far.

But bleached paperboard has high resale value as a recycled material because of its long, high-grade, bleached fibers. No less than six new technologies in various stages of development are making the recycling of plastic-coated paper items possible, even for reuse in food packaging (Brewer, 1989). International Paper, for example, is testing the feasibility of recycling post-consumer paperboard milk and juice cartons used in institutional settings. Approximately 50,000 cartons per week are being shredded and sanitized into clean, odor-free materials for use in paper and paper products (Reuse Recycle, 1990a).

Flexible Packaging: Packaging paper, although now often replaced by plastic films, still accounts for about 5 million tons of paper packaging. Strength requirements have traditionally kept recycled content low. It is difficult to estimate the fraction of this packaging that is recycled since it is just one of many components of the mixed paper waste stream which has an overall recovery rate of 13% (Graeme, 1990).

PAPER: OUTLOOK

Paper recycling rates overall are already high, and even higher for specific uses of paper (such as corrugated cardboard), and the industry is geared up for significant increases beyond current levels. A plethora of new recycling technologies and product designs augurs well for the rapid achievement of new paper recycling goals.

GLASS

About 12.9 million tons of glass were discarded in 1986, approximately 90% of which was container glass. Glass containers are used to package food, beverages, cleaners, and other consumer products.

Glass Container Use in 1990:

Food	33.4%
Beverages	22.9%
Beer	31.6%
Liquor	3.5%
Wine	4.9%
Medicinal	2.2%
Chemicals	0.5%
Toiletries	1.0%

(Source: Glass Industry, 1990)

FEASIBILITY OF GLASS RECYCLING

Glass is 100% recyclable; that is, one pound of recycled glass makes one pound of new glass (OTA,1989). Glass also does not degrade when recycled, and thus can tolerate very high levels of recycled content. Moreover, because recycled glass improves melting efficiency, it is now commonly used by glass makers in the manufacture of new containers.

GLASS RECYCLING RATE: 25-30%

Currently, the overall use of post-consumer cullet, or recycled waste glass, is estimated to be about 25% to 30%, up from 15% in 1988. (OTA,1989). The industry has in fact announced an overall goal of 50% cullet usage and has set up glass recycling programs spanning more than half the United States (Gibboney, 1990).

GLASS COLLECTION AND RECYCLING INFRASTRUCTURE

In large enough amounts, mixed-color cullet can cause chemical composition problems during the manufacturing process. At present, the procedures for color sorting of waste glass are not able to achieve sufficiently high levels of color separation, thus limiting the amount of cullet usage in glass container manufacturing. As much as 70-80% cullet usage could occur with improved processing (OTA, 1989).

The glass industry is, however, continuing to improve mechanical color separation techniques, technologies to clean and process used glass containers, and modifications in packaging design to facilitate cleaning and processing. Even with the current technology, industry believes that cullet usage can be increased substantially.

GLASS PRODUCT DESIGN

Container cullet is used mainly for the manufacture of new containers and fiberglass. The major factor limiting the use of cullet in glass making is the buyer specifications for color. The color mix specifications for producing all glass containers (especially the uncolored ones) are quite strict. Two-thirds of the glass made in the U.S. is clear, which requires the lowest color mix levels. If buyers reduce their use of clear glass in applications where the color is not critical, a higher fraction of cullet could be utilized. Mixed-color cullet can also cause color or chemical composition problems during the melting process (Gibboney, 1990).

Mixed-color, post-consumer cullet can potentially be used in the manufacture of fiberglass, but the cullet must be highly contaminant-free. Simple product modifications, such as elimination of ceramic-and-wire caps, could eliminate some contaminants.

Crushed post-consumer waste glass can also be used as a replacement for sand and gravel in asphalt production. The advantage of this end-use is that cullet quality is not a major consideration. On the down side, however, this market is not very profitable because of the low cost of sand and stone.

Finally, it is important to note that because glass is easily cleaned and returned to commerce, it is an ideal material for reusable containers. Reusable milk and beer bottles are common, and one California firm washes 9.3 million wine bottles annually for resale to wineries (Gitlitz, 1990). Reusable bottles in many ways are an environmentally ideal container: reuse accomplishes source reduction and then, once the container is no longer reusable, it can be recycled into new glass.

GLASS RECYCLING: OUTLOOK

Projected recycling rates for glass would qualify this material for all packaging uses under proposed recycling rate standards. Moreover, continued innovations in separation techniques and product design will allow for significantly higher levels of recycled content and offer tremendous potential for reuse of glass bottles.

ALUMINUM

About 76-79% of the aluminum in municipal solid waste consists of aluminum cans, and the remainder consists of other packaging (such as foil, pie plates, and frozen dinner trays), containers, discarded appliances, lawn furniture and other items (EPA, 1988; Aluminum Association, 1989).

FEASIBILITY OF ALUMINUM RECYCLING

Aluminum is easily recycled with existing technologies. Historically, aluminum produced from recycled materials has accounted for about 20% of the supply available to industry. This figure does not include scrap generated from the production of aluminum products (OTA, 1989; Aluminum Association, 1989).

ALUMINUM RECYCLING RATE: 35.3%

The recycling rate for all aluminum is estimated to be 35.3% (OTA, 1989). Aluminum cans, the most significant source of aluminum in MSW, are recycled at a rate of 60.8% (Aluminum Association, 1990). Many products containing aluminum -- architectural panels, industrial equipment, transportation equipment, and durable goods -- have long life cycles and therefore are not significant contributors to typical post-consumer scrap sources, as packaging is. Aluminum cans, which do contribute to MSW, are highly valued in recycling programs because of their high market value and thus will continue to be collected at high rates.

ALUMINUM RECYCLING INFRASTRUCTURE AND PRODUCT DESIGN

Aluminum scrap is now recovered industrially, from municipal solid waste, and by scrap dealers. Industrial recovery includes scrap cuttings and defective aluminum products. Because of its extremely high market value, post-consumer aluminum recycling is highly developed and few radical changes are foreseen in the future.

ALUMINUM: OUTLOOK

Thanks to its high market value, aluminum will continue to be recycled at high rates, and cans -- which can be made of recycled aluminum -- will undoubtedly comply with recycling standards.

IRON AND STEEL

The amount of ferrous scrap in MSW was estimated to be 11.0 million tons in 1986. About 25%, or 2.8 million tons, consisted of packaging such as food and beverage cans. The remainder of the material was found in major appliances and durable goods.

FEASIBILITY OF IRON AND STEEL RECYCLING

Steel is easily recycled with existing technologies. In 1986, in fact, U.S. steel mills actually consumed more scrap than virgin material: 49.7 million tons of scrap and 44.3 million tons of raw steel, for a total production of 81.6 millions tons (OTA, 1989). Steel has the added benefit of being infinitely recyclable, so degradation is not a concern with this material.

IRON AND STEEL RECYCLING RATE: 66%

Ferrous scrap is recycled at a rate of 66%. Steel cans, the primary use of steel in packaging, are recycled at a rate of 15.1% (Apotheker, 1990).

IRON AND STEEL RECYCLING INFRASTRUCTURE

Ten years ago the future of steel can recycling was uncertain due to abundant supplies of raw materials and limited interest in recycling. But concerns over the solid waste crisis, shortages of industrial scrap, and new technology for shredding and processing tin-coated cans have all been key factors in the rebirth of the steel can recycling industry (Resource Recycling, 1990b). In fact, observers suggest that the introduction of recycling standards for packaging has become the containers' number one benefit and the key to future stability of the detinning (steel cans are coated with tin) and recycling industry (Resource Recycling, 1990a).

The key to improving recycling is increased awareness that steel cans are recyclable. Industry has increased its recycling capacity to handle 25% of the steel waste generated (Resource Recycling, 1990a). Expanded capacity and higher prices for recycled scrap are convincing more curbside collection programs to include steel cans, some of which have already achieved capture rates of up to 45%. High scrap values have also interested the major waste haulers in increasing steel recycling. Finally, magnetic separation systems at waste processing facilities will improve separation capability (Resource Recycling, 1990a).

IRON AND STEEL: OUTLOOK

Recycled scrap is a staple for steel mills, the industry is eager to expand collection programs and recycling capacity, and prices for post-consumer steel are rising. Recycling standards will only increase the impetus to recycle. With overall recycling rates extremely high and markets growing for post-consumer scrap, steel is highly likely to qualify for packaging uses under proposed recycling standards.

PART TWO: PRODUCT PACKAGING CAN COMPLY WITH RECYCLING STANDARDS: FIVE CASE STUDIES

In the previous section, we studied the potential for overall compliance with recycling standards for broad categories of materials: plastics, paper, glass, and metals. Of more immediate concern to consumers, however, is how these macroeconomic developments will translate to the local supermarket or department store. Will the food and consumer products we enjoy and rely on still be available if recycling standards for packaging go into effect?

In this section, we have tried to take a fresh look at the way commonly used products are packaged. We obviously could not examine every product, or even a significant fraction of the many thousands of consumer and business products sold in disposable packaging. Instead, we focused on five commonly used products, many of which the naysayers claim are the "tough" cases, the ones for which recycling standards would simply be impractical.

The five items we examined are milk, shampoo, computer equipment, microwavable food, and food wrapped in plastic. To test the common wisdom about these products, we interviewed dozens of people in the packaging business: manufacturers, packagers, distributors, and retailers. What we found may be surprising. In each case, simple changes in design or expanded use of recycling technology already available today can guarantee effective delivery of the product in question. Multiplied by thousands of products and millions of consumers, these simple changes typify the dramatic benefits achievable when industry is forced to practice the art of the possible.

Preliminary Note: The FDA and Recycled Content

There is an enormous amount of confusion and contradictory information regarding Food & Drug Administration (FDA) regulations and the use of recycled materials in food packaging. Many industry people we interviewed believe that FDA regulations prohibit recycled content. This is not the case.

The federal Food, Drug and Cosmetic Act contains no such prohibition. It mandates simply that no food package should cause food to be adulterated. FDA regulations issued pursuant to the Act are hardly more specific. Title 21, part 176.260 specifically permits the use of paper reclaimed from industrial waste or salvage. And there are no specific restrictions on the use of post-consumer paper pulp, nor are there regulations regarding the use of recycled plastic (it must simply meet the safety standards established for virgin plastic) or recycled glass (generally recognized as safe by the FDA, according to Kenneth Falci, Supervisor of the Consumer Safety Office in the FDA's Division of Food and Color Additives).

The manufacturer's obligation with regard to recycled material, just as it is with regard to virgin packaging material, is to ensure that it will not adulterate the food, i.e., that it has not come into contact with harmful materials that can migrate into food.

In the manufacturers' defense, the FDA has sent mixed signals on this issue (Plastics News, 1989). Yet many food packagers already use recycled materials in, for example, molded paper egg cartons and meat trays, and in cereal boxes. And in January, 1991, the FDA for the first time approved the use of recycled plastic in food packaging (Coca-Cola bottles), saying they would consider the use of recycled materials in food packaging on a case-by-case basis.

It is now incumbent upon both packagers and the FDA to clear up any remaining confusion over recycled content so that recycled materials can be used to the maximum extent possible that is consistent with public health and safety.

CASE STUDY #1: MILK

BACKGROUND

Milk Packaging Today

The days of milkmen delivering fresh dairy products in glass containers to each consumer's door and collecting the empties are gone for most communities. Milk containers are now sold primarily in grocery stores and are made out of coated paperboard, HDPE (high-density polyethylene) plastic, and, infrequently, glass.

About 85% of larger sized milk containers (greater than a quart) are made of plastic. Currently, about 740 million lbs. of HDPE plastic is used in this country for milk containers (Modern Plastics, January 1988). In smaller sizes, coated paperboard dominates (Tufts, 1988). More than a third of coated paperboard sales in Massachusetts are for milk and other beverage containers (TBS, 1990).

Paperboard	HDPE	Glass
half-pints		half-pints
quarts		quarts
half-gallons	half-gallons	
	gallons	

Considerations in Milk Packaging Design

Milk packaging must be hygienic (bacteria-free) and barrier resistant to moisture.

When considering changes in milk packaging, one must consider the economic and environmental costs -- of producing containers, of washing and re-using bottles -- as well as hygiene. Plastics manufacturers claim that, <u>for a single use</u>, plastic containers require less energy to produce than paper or glass (Nir, 1990a). But using materials a single time is wasteful and environmentally harmful and is precisely what should be avoided. Recycling plastic milk containers saves enormous amounts of energy, and reusing glass milk bottles many times makes that material economically competitive.

According to Garelick Farms, costs for half-gallon plastic containers are $.10 and coated paperboard $.15. While one source puts the cost of glass at $.72 for a quart bottle, that estimate is for a single use and decreases with each successive reuse (Tufts, 1988). There is at least one dairy in Massachusetts (Brookside Dairy) that uses glass, and others may as well.

MILK CONTAINERS: METHODS FOR COMPLIANCE WITH RECYCLING STANDARDS

1. Use Paperboard Cartons

a. Paperboard Will Meet Recycling Rates: Milk cartons made of polycoated or waxed paperboard will comply with recycling standards thanks to the high overall levels of paper recycling, since the coating constitutes an insubstantial part of the packaging. Furthermore, new recycling techniques offer the potential for recycling coated paperboard (see discussion in Part One, above).

b. Cartons Can Be Made of Recycled Paper: An second avenue for paperboard containers is to use recycled paper fiber, depending on the resolution of recycled content issues with the FDA (see above) and on relevant state laws. Massachusetts, for example, prohibits the reuse of paperboard milk cartons, but does not prohibit the use of sanitary recycled paper fiber (Mass. General Laws chapter 98, section 17).

2. Use Glass Bottles

Surveys have indicated that consumers prefer glass for preserving the taste and flavor of certain foods (Tufts, 1988), a preference which may be reinforced by the environmental benefits of glass and new concerns about plastic leaching into food. Glass can meet environmental standards in three ways:

a. Glass Will Meet Recycling Rates: (see Part One, above)

b. Glass Can Be Reused: Refillable glass bottles offer the greatest waste reduction and energy conservation advantages, but would entail the re-establishment of the infrastructure for bottle collection and cleaning. This could be accomplished either through municipal recycling programs or directly through supermarkets, distributors and dairies (perhaps with a deposit system). For example, two northwestern beer breweries, G. Heileman Brewing Co. and Rainier Brewing Co. (Portland, OR, and Seattle, WA), have recently made strong commitments to refillable beer bottles, while a California company profitably collects, transports, and cleans 9.3 million wine bottles annually for resale to local wineries (Glitz, 1990).

c. Bottles Can Be Made of Recycled Glass: The FDA generally recognizes recycled glass as safe.

3. Use Reusable, Recyclable Plastic Bottles

a. **Plastic Can Be Reused:** General Electric has developed an engineered plastic resin that can be sterilized and refilled up to 100 times, after which it can be recycled. GE contends that, despite higher initial production costs, such extensive reuse would actually result in lower consumer cost (GE, 1989).

b. **HDPE Can Meet Recycling Rates:** Recycling rates for HDPE plastic are already rising, primarily because of milk jug collection. High rates of plastic milk jug recycling can be accomplished through aggressive municipal collection programs, provided the jugs are pure, uncolored HDPE to allow for maximum recyclability.

The Interviews:

1. Garelick Farms, Phil Drexler, Franklin, MA, 8/23/90.
2. Bread and Circus, Boston, MA, Craig Wetherby, 8/17/90.
3. Food & Drug Administration, Kenneth Falci, Division of Food and Color Additives, 10/29/90, John Nichols, Milk Safety Division, 10/31/90.

CASE STUDY #2: SHAMPOO

BACKGROUND

Shampoo Packaging Today

Plastic has made tremendous inroads into the cosmetics container industry in recent years. In Massachusetts, for example, one of every seven plastic bottles sold is for hair or personal products. Total plastic bottle sales are expected to grow by 15% annually (TBS, 1990).

Currently most shampoo bottles are made of virgin HDPE. In 1987, 184 million lbs. of HDPE was sold in the U.S. for cosmetics bottles alone (Wirka, Wrapped in Plastic; EAC, Collision Course, p. 10). Plastic bottles can also be made of polypropylene, which is more expensive, or LDPE (low density polyethylene), which is not as tough as HDPE and generally not used for shampoo since it will stress crack when in contact with certain soaps.

Considerations in Shampoo Packaging Design

Shampoo bottles, as well as those used for other personal care products (conditioner, lotion, liquid soap, cream, nail polish remover, baby oil, bubble bath, contact lens solution), primarily need to be barrier resistant. Glass is also barrier resistant, and in fact is a more effective barrier than plastic, but it is neither lightweight nor shatterproof. For shampoo, therefore, plastic bottles offer a significant consumer advantage over glass by being nonbreakable, lightweight, and (sometimes) squeezable.

SHAMPOO BOTTLES: METHODS FOR COMPLIANCE WITH RECYCLING STANDARDS

1. Use Bottles Made of Single-Resin Plastics Which Meet Recycling Rates

Shampoo bottles made of single-resin plastics would comply with recycling standards for packaging once those materials were collected and recycled at sufficient rates. Currently, HDPE single polymer plastic bottles (such as milk jugs and detergent bottles) are being recycled in a number of programs around the country. PET, which has achieved the highest plastic recycling rates, can also be used for shampoo bottles, particularly with the recent development of multi-layer, recyclable PET containers with superior barrier resistance properties. Proctor & Gamble is already moving some of its household chemicals into 100% PET bottles. Finally, 100% polypropylene (PP) bottles have also been developed, though PP is generally more expensive and needs a higher melting temperature for recycling.

2. Use Bottles Made of Recycled Plastic

The technology for recycled content is already available; and while companies need to invest in capital equipment to handle recycled material, some manufacturers believe that the lower cost of recycled resin will actually make these bottles cheaper to produce. The chicken-and-egg problem here is the need for a steady, high quality supply of post-consumer material.

Recycled HDPE: Three companies -- Plastipak in Michigan, Continental Can in Connecticut, and Northwestern Bottle Co. in Missouri -- are producing plastic bottles for Tide, Cheer and Era detergents which contain an average of 25-35% post-consumer recycled HDPE. These bottles are generally composed of three layers, just one of which (the middle layer) is recycled material. But Plastipak is trying to increase recycled content by putting recycled material in the outside layer, and Northwestern Bottle claims to use up to 60% recycled content in its HDPE bottles. Developing technologies, such as the use of a micro-thin glass barrier layer, may allow for even greater recycled content.

Recycled PET: Plastipak has designed a 100% recycled plastic bottle made from PET material collected through bottle return laws. This bottle is currently being used by Proctor & Gamble for a cleaning product (Spic and Span). The manufacturer and the Center for Plastics Recycling Research at Rutgers claim that these bottles can be recycled again in existing recycling programs that normally handle materials composed of virgin plastic.

3. Other Possibilities

a. Refill and Reuse Durable Plastic Bottles: Plastic shampoo bottles are sturdy and durable and thus can be collected for washing and refilling. The Boston Food Co-op has refilled consumers' shampoo bottles for 20 years without any health, safety, or legal problems. The Body Shop, a California-based cosmetics store, encourages consumers to refill bottles at the shop with a $.40 incentive.

Successful examples like these refute the claims of mainstream industry that refilling and reusing plastic bottles is impractical or unworkable. Companies that express concern about hygiene, like Proctor & Gamble, could set up deposit programs and clean and refill shampoo bottles themselves. A Massachusetts company called Peppers, in fact, already encourages customers to return their used bottles (although rather than refilling them, Peppers separates the bottles according to resin and brings them to a South Boston recycler). In Bottle Bill states, collection could begin immediately in supermarkets, as part of the collection and separation mechanism already in place for soft drink bottles.

b. Reduce Packaging By Selling Concentrates: As Proctor & Gamble is doing with fabric softener, shampoo makers could sell refills for full-size shampoo bottles in concentrate form to which the consumer simply adds water. The fabric softener experiment has both reduced the amount of packaging used and lowered costs significantly for consumers.

The Interviews:

1. American National Can Co., Greenwich, CT., makers of 100% polypropylene bottle; Jennifer Meyers, 8/18/90.
2. Plastipak, Michigan, makers of 100% recycled PET bottle and recycled HDPE bottles; Tom Bussard, 8/16/90.
3. Proctor and Gamble, Cincinnati, Tom Rattray, 8/14/90.
4. Continental Can/Continental PET, Norwalk, CT., makers of Heinz Ketchup multilayer PET bottle and HDPE recycled bottles; John McDonald, 8/15/90.
5. Northwestern Bottle Co., St. Louis, MO, makers of HDPE recycled bottle; 8/18/90.
6. Boston Food Co-op, Howie Michaelson, 8/17/90.
7. Tellus Institute, Mark Rossi, 8/15/90.
8. The Body Shop, San Francisco, CA, 8/27/90.
9. Peppers, Boston, MA, 8/27/90.

CASE STUDY #3: COMPUTER EQUIPMENT

BACKGROUND

Computer Packaging Today

Computers and computer equipment, as well as other sensitive electronic equipment, are generally shipped in corrugated cardboard boxes. For cushioning, packagers rely primarily on blown polystyrene stuffing, which includes loose fill ("styrofoam peanuts") as well as the more rigid, molded inserts. Many companies are now beginning to reject loose fill because it creates a mess when opened and because it may settle during transport in a manner which compromises the safety of the equipment.

Considerations in Computer Packaging Design

Computers are delicate equipment and need to be packaged to withstand the impact of transportation. This is the primary function of computer packaging.

A second consideration is fit: the size and shape of packaging material needs to vary in accordance with the size of the computer components. One size does not fit all.

Finally, computer packaging should be amenable to automation. In large companies, computers are packaged in automated assembly lines. It is important, therefore, that the stuffing material easily fit around the computer.

COMPUTER PACKAGING: METHODS FOR COMPLIANCE WITH RECYCLING STANDARDS

1. Reduce Packaging By Custom Fitting

Some companies now die-cut boxes to match the specific size of machinery. As a result, both the size of the box and the amount of stuffing required are minimized. As part of an effort to eliminate its use of CFC (chlorofluorocarbon)-blown foam, for example, AT&T recently redesigned its consumer products packaging and achieved a 20% reduction in packaging. The company also realized a concomitant benefit by reducing its transportation costs (since shipping volume had been reduced).

2. Use Corrugated Cardboard Boxes

a. Corrugated Cardboard Will Meet Recycling Rates: Paper, overall, will achieve required recycling rates, and corrugated cardboard in particular already is recycled at a rate of 52%.

b. Boxes Can be Made of Recycled Paper: Currently, computers are packaged in corrugated cardboard which often has a recycled content of 20-70%. To ensure adequate material strength, IBM has recommended recycled content levels of 30% to 50% for single-walled boxes (made of two liners and a medium), 40% to 70% for double-walled boxes (one additional medium and liner), and 40% to 70% for triple-walled boxes (one more medium and liner). Since most recycled material is contained in the medium, recycled content increases with each extra layer.

3. Use Reusable Polyethylene Foam Stuffing

Dow Chemical is one of a number of companies that now makes an expanded, blown foam from LDPE (low density polyethylene), which it calls Ethofoam. This product, used in exercise mats and life preservers, is semi-rigid, non-brittle, more durable than polystyrene (the material commonly used now for stuffing or filler), and can be re-used at least 10 times. When attached to cardboard to fit the exact contours of the computer equipment, it can be handled by automated packing machines. While polyethylene foam is usually more expensive than polystyrene per square inch, less of it is usually required, particularly when attached to cardboard.

Resource America, a new company located in Princeton, N.J., is working with computer companies and plastics manufacturers to develop a pioneering collection and distribution system to facilitate the reuse and eventual recycling of polyethylene, polypropylene, and urethane foam used in computer packaging. Consumers would receive a return label, postage paid, to mail packaging (either in the computer box or in a separate enclosed bag) to the Resource America facility. Resource America would inspect the material, refurbish it if necessary, and then sell it back to the original computer company for a discounted fee. At the end of its useful life, the material would be returned to Dow for recycling. A participation rate of at least 50% is anticipated. Dow, IBM and Hewlett Packard are now participating or considering participating in this program.

4. Use Recycled or Recyclable Paper Stuffing

Paper cushioning material can be used for smaller or less fragile computer or other electronic equipment. AT&T, for example, now uses corrugated cardboard, rather than foam, to protect the company's line of small consumer products, telephones, and answering machines.

A variety of innovative paper packaging has already been developed to replace foam for other bulky but not fragile products. EcoPak, based in Kent, Washington, is marketing a spring-loaded, 100% recyclable packing material made from second- and third-grade reject Kraft paper that expands upon impact, doesn't settle during shipping, and actually provides better protection when the package is roughly handled. Deltapack3, produced by Deltapaper in Croyudon, Pennsylvania, is a 3-ply cushioned wrap made from 100% recycled materials that can substitute for bubble wrap or styrofoam peanuts and weighs just one more ounce per carton than foam (In Business, July/August 1990).

5. Other Possibilities

The plastics industry is heavily subsidizing efforts to recycle polystyrene, most notably at the Plastics Again recycling facility in Leominster, MA. Polystyrene recycling is happening on a very small scale, however, and has thus far been limited to food containers since polystyrene computer packaging usually contains a flame retardant chemical that may inhibit recycling.

The Interviews:

1. Resource America, Princeton, N.J., Michael Grey, President, 8/24/90.
2. IBM, Mechanicsburg, PA, Chuck Tuson, 8/23/90.
3. Roger's Foam, MA, converters of polyethylene foam & makers of custom designed packaging, 8/15/90.
4. Dow Chemical, Ron Morrow, 8/17/90.
5. Mac Connection, Peter Hass, Marlow, N.H., 8/16/90.
6. Plastics Again, Leominster, MA, 8/16/90.

CASE STUDY #4: MICROWAVED FOOD

BACKGROUND

Microwave Packaging Today

The advent of the microwave oven has spawned entire lines of frozen and preserved foods and complete meals in "convenient" packaging. Often cited as a prime example of excessive packaging waste, microwave packaging generally consists of the following:

(1) an outer box: most packagers use plastic- or wax-coated virgin paperboard;

(2) a cooking tray (not used by all packagers): microwave trays are usually made of plastic, though some are low density plastic-coated paperboard. The plastic trays are often multi-layered, and usually made of crystallized PET or polypropylene;

(3) an inner wrapping: these inner liners are made of flexible plastic film (see Case Study #5 for a discussion of plastic film).

Considerations in Microwave Packaging Design

Microwave packaging must keep food fresh and dry (frost-free industrial freezers are quite humid). Those elements of the packaging which are put into the microwave oven with the food must be able to withstand extreme variations in temperature, and cannot be made of metal. Since the raison d'etre of microwave packaging is its convenience, attention must also be paid to this consumer preference.

MICROWAVE PACKAGING: METHODS FOR COMPLIANCE WITH RECYCLING STANDARDS

1. Use Paperboard Boxes

a. Paperboard Will Meet Recycling Rates: Outer boxes for microwave foods made of polycoated or waxed paperboard will comply with recycling standards thanks to high overall levels of paper recycling, since the coating constitutes an insubstantial part of the packaging. New recycling techniques, though, do offer the potential for recycling coated paperboard.

b. Boxes Can Be Made of Recycled Paper: A second avenue for paperboard boxes is to use recycled paper fiber, particularly where food contact is not an issue because of inner plastic liners. Boxes coated with plastic or wax to ward off moisture and preserve structural integrity can be made with recycled paper content. The James River Paper Co., a producer of virgin and recycled paperboard, is already beginning to consider putting recycling facilities in integrated pulp mills, and may in the future create a composite recycled/virgin material.

2. Eliminate Disposable Cooking Trays

This reasonable, easy-to-accomplish step already taken by some packagers would probably guarantee environmental acceptability under some packaging reduction proposals. It not only provides the best solid waste solution for excessive microwave packaging, it may also offer a health benefit to consumers. Toxic plastic monomers, cyclic PET trimers, plasticizers, and adhesives have been found to leach into food from the microwave heating process (Nutrition Action Health Letter, Jan-Feb. 1990). Eliminating the trays would eliminate the leaching problem.

For food safety as well as environmental reasons, glass is a better microwavable material than plastic. Glass trays, standardized in size and sold separately from the packaged microwave meals (therefore not considered packaging), could be used innumerable times by consumers. This approach is preferable to the rhetoric of manufacturers who claim their plastic packaging trays are "reusable." There are no systems in place for packagers to collect trays for reuse, nor will consumers need yet another "reusable" microwave tray with every purchase.

3. Use Trays Made of Single-Resin Plastics Which Meet Recycling Rates

Nestles Freshness Foods uses disposable plastic cooking trays made of crystallized PET (CPET), which it claims can be recycled in PET recycling programs (though some dispute this). Freshness Foods says it is also looking into a clear PET tray.

(For ways of dealing with plastic film in microwave packaging, see Case Study #5, below.)

The Interviews:

1. Worthington Foods, Washington, Ohio, makers of Natural Touch products, Helen Overly, 8/15/90.
2. Textile Printing, Chattanooga, TN, suppliers of poly-coated paperboard, Kurt Schmissrauter, 8/15/90.
3. Nestles Freshness Food, Jim Macey, 8/17/90.
4. James River Paper Co., producers of recycled and virgin paperboard, Frank Vincent, 8/17/90.
5. Stouffer, Mike Odette, 8/17/90.

CASE STUDY #5: FOODS WRAPPED IN PLASTIC

BACKGROUND

Plastic Food Wrapping Today

The use of plastics has grown explosively in the United States, nowhere more than in the use of plastic film. Plastic film is now used to wrap a variety of foods, including baked goods, candy, dairy products, frozen food, meat and poultry, seafood, and produce, in addition to other consumer and manufacturing goods.

Most plastic film is made from LDPE (low density polyethylene). Food wrapping uses include baked goods, dairy products and shrink wrap. Though it is the most widely used film resin, only 15-20% of all LDPE is used to make film used for food wrap. Other film resins include PVC (polyvinylchloride), PP (polypropylene), PVDC (polyvinylidene chloride), and HDPE (high density polyethylene). One percent of the film used is cellulose or cellophane, a compostable wood fiber product, which is used on cigarette packages and other products.

Considerations in Food Wrap Design

Our present food distribution system often requires foods to have a shelf life of several weeks or even several months. Some perishables (meat, fish, cheese) are vulnerable to spoilage in even shorter periods of time.

Plastic film has become a popular flexible packaging material because it is transparent, barrier resistant to moisture and air, form fitting, and inexpensive. Paper is not barrier resistant, transparent, or as form fitting. Metal foil is barrier resistant and relatively form fitting, but not transparent.

FOOD WRAPPING: METHODS FOR COMPLIANCE WITH RECYCLING STANDARDS

1. Reduce Use of Plastic Wrap Where It is Unnecessary

Many foods are now packaged with a second or even third layer of plastic film packaging, sometimes to delineate "individual servings," sometimes to provide an extra "freshness seal," and sometimes simply for appearance. Eliminating unnecessary packaging is the first step toward compliance with recycling standards.

On a larger scale, shortening food distribution channels can reduce both shelf time and the need for packaging (including barrier-resistant plastic film). Examples of such changes would include buying more food from local sources, shipping and selling more food in bulk, increasing the use of deli counters where meat and cheese is cut on demand and can be wrapped in foil or paper, and allowing consumers to package food in paper bags or reusable containers.

2. Use Reusable Containers Instead of Film

Plastic film use can be reduced by selling food in more durable plastic or other materials which can either be reused or recycled. Food co-ops and some supermarkets already allow consumers to bring their own containers, though issues of convenience and hygiene need further exploration.

3. Substitute Environmentally Superior Materials for Plastic Film Where Possible

A major obstacle to finding workable substitutes for plastics is an attitudinal one. The representatives of plastics manufacturers, packagers, retailers, and food producers that we interviewed were very resistant to the idea of finding substitutes for plastic film, calling the idea "absurd." But substitutes do exist.

Paper (recycled, recyclable) can be used where food needs to remain fresh for only a day or two, or where spoilage is not a concern (such as with paperboard boxes for dry pasta and grain products). **Foil** (recycled, recyclable) can substitute for plastic film in many applications. **Cellulose or cellophane** (compostable) is the original flexible packaging developed in the 1930s. Offering the benefit of transparency, cellophane unfortunately is permeable, letting in and out moisture and gases, unless coated with a layer of plastic. Cellophane can, however, be used to wrap produce, prepared foods (sandwiches), bakery items, and nuts and grains. The Massachusetts-based Bread & Circus Natural Food Markets and Seasons' Harvest successfully use cellulose wrap.

Another potential substitute is so-called **natural plastic** made of bioengineered, fully compostable natural polymers. The New York Times reports several American and European companies already producing and selling these products (Oct. 21, 1990).

4. Use Packaging With Recycled Content

Plastic film is extraordinarily lightweight. As a result, packages that use plastic food wrapping in conjunction with outer boxes, bags, trays or other material made of recycled content would most likely comply with recycled content standards that are based on the weight of the entire package. Shop 'n Save supermarkets in Maine, for example, now sell meat that is wrapped in PVC film but sits on molded, recycled paperboard trays. By weight, this type of packaging has an overall recycled content which would comply with proposed recycling standards. By the same token, recycled LDPE or HDPE can be used for heavier outer bags for products, like bread, which have an inner liner that comes into contact with the food. Some plastic grocery sacks, for example, now consist of 50% recycled material.

5. Use Film Made of Single-Resin Plastics Which Meet Recycling Rates

Collecting and recycling plastic film used to wrap foods presents a number of practical difficulties. But even if that film is not itself collected and recycled at high rates, food wrap could be made of plastic resins which achieve high statewide recycling rates from other uses. As pointed out above, less than one-fifth of all LDPE is used to wrap food, even though LDPE is the most common film resin. Aggressive recycling efforts targeted at other forms of LDPE packaging and products could bring recycling rates to required levels even without recycling food wrap.

Obstacles to film recycling include food contamination and the difficulty of collecting amorphous film and identifying resins. Standardizing and labeling resins and using advanced recycling technologies, however, as described in Part One, may minimize these problems. Successful collection and recycling has been accomplished for LDPE and HDPE grocery sacks, trash bags, and cleaners' bags. A Canadian Company (PCL Group, in New Brunswick) is currently recycling flexible LDPE packaging in Canada and New England, and Washington state food manufacturer Turtle Island Soy Dairy asks consumers to send back their polyethylene packaging, which is then sent to a recycling plant in Oregon.

The Interviews:

1. Arrowhead Mills, Hereford, TX, Joe Hecker, 8/14/90.
2. Purity Supreme, Boston, MA, Ken Goode, 8/14/90.
3. Beresford Packaging, Taunton, MA, Pam Swaton, 8/14/90.
4. Little Bear Organic Foods, Pacific Palisades, CA, Luke Ncee, 8/15/90.
5. Frito Lays, Malborough, MA, Emily Fagundo, 8/16/90.
6. Anheiser Busch, Eagle Snack Division, St. Louis, MO, Jack Bickler, 8/23/90.
7. Biocycle Magazine, Emmaus, PA, Nora Goldstein, 8/27/90.
8. Council on Solid Waste Solutions, Washington, D.C., Susan Vadoney, 8/27/90.
9. Flexel, Atlanta, GA, producers of cellophane, Hank Purgasen, 8/23/90.
10. Ziff Co., converters of cellophane, Worcester, MA, Bill McKenna, 8/16/90.
11. Ecco Bella, Caldwell, N.J., sellers of cellophane bags, 8/17/90.
12. Northeast Cooperatives, Brattleboro, VT, Martha, 8/17/90.
13. Flexible Packaging Industry, Washington, D.C., Rick Thoneberg, 8/14/90.
14. Seasons' Harvest, Somerville, MA, Mr. Reis, 8/15/90.
15. Forrest Brokerage, Inc., makers of recycled molded paperboard, Michael Forrest, 10/1/90.

CONCLUSION: MASTERING THE POSSIBILITIES

The information contained in this report should provide a sense of the tremendous potential for reducing, recycling and redesigning product packaging as a key component of a long-term solution to the solid waste crisis.

It should also be noted that our research has uncovered more than just "potential." The myriad instances of ground-breaking technologies, innovative collection and separation techniques, and advanced product designs cited here demonstrate in striking fashion the momentous changes already afoot. Many sectors of the manufacturing, packaging and recycling industries have begun to accept responsibility for the solid waste challenges we face and to take advantage of the business opportunities they present. Setting mandatory recycling standards would ensure that all sectors of industry take that responsibility seriously.

Of course, not all of the possibilities and options described in this report may be desirable for consumers or cost-effective for industry. But those questions are for the free market to decide. And that is one of the most attractive features of the proposed recycling standards discussed in this report. Decisions about how best to comply with these standards would be left to those best able to make such determinations: the affected businesses themselves. What our findings show, however, is that industry will be able to comply with the recycling standards that have been proposed in many states.

Another example of the flexibility of the proposed recycling standards we looked at is that they provide for conditional exemptions for specific types of packaging. It is conceivable, for example, that a narrow exemption may be necessary or appropriate for certain limited uses of plastic film where needed to protect the safety or freshness of certain foods or medical supplies. While we believe that even these products will be able to be packaged in ways consistent with recycling standards (through appropriate use of recycled materials or materials that comply with mandated recycling rates), the availability of such exemptions should allay the fears of even the most intransigent critics.

The profusion of recent advances and future possibilities in packaging design, construction and recycling far exceed what the common wisdom would have us believe. They also contradict industry predictions that mandatory recycling standards would lead to wide-spread product bans and empty supermarket shelves. The possibilities for reduction, redesign and recycling of product packaging are certainly there; enacting recycling standards for packaging may be the only way to push the free market to master those possibilities.

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