PA/SW-29

THE SALVAGE INDUSTRY

what it is how it works

This condensation (SW-29c.1) is based on
Salvage Markets for Materials in Solid Wastes
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and was prepared for the
Federal solid waste management program
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For sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, D.C. 2040
Price: 40 cents, domestic postpaid, 30 cents, GPO Bookst
Stock Number 5502–00108

U.S. ENVIRONMENTAL PROTECTION AGENCY
1973

THE SALVAGE INDUSTRY
what it is—how it works

Salvaging materials in solid wastes is an essential part of improved solid waste management: It reduces the quantity of wastes requiring collection and disposal. At the same time, it helps conserve valuable natural resources.

But salvaging has not traditionally been viewed as a solution to waste management problems. The activity has been a necessity, pursued for its own sake. Man has alway scrutinized wastes and has extracted whatever valuable materials he could. The reason was simple: It required less human energy to recover waste materials than to obtain and process virgin raw materials.

In the latter half of the 20th century, in a few highly developed countries of the world, modern technology and the use of fossil fuels have created a situation where this frequently is no longer true. Consequently many materials that in earlier times would have been recovered are now discarded.

This decline in salvaging of wastes comes at a time when the American people are showing great interest in resource recovery. Schools and other civic groups organize drives to collect bottles, cans, and paper, and neighborhood recycling centers are being established. These moves may increase the supply of salvaged materials, but they do not necessarily increase demand—as many dedicated volunteers have found out when no scrap dealer wanted his bottles, cans, and paper.

Recognizing that availability of markets is crucial to greater use of waste-derived materials, the U.S. Environmental Protection Agency contracted for a study to evaluate potential markets. The study, by Arsen Darnay and William E. Franklin, Midwest Research Institute, Inc., Kansas City, Missouri, focussed on the economics of recovering the commodities encountered in municipal wastes and on how the salvage industry handles these commodities.

THE SALVAGE INDUSTRY

Salvaging of wastes has never been a major activity of mankind (like transportation, agriculture, or construction), but it could always be found on the margins of major activities. For this reason, it is a somewhat mysterious activity, poorly lighted by statistical facts and reporting systems. It is a world of small entrepreneurial ventures—sometimes the part-time business of one man—with prices that shift like quicksand, poor records, and a demand-supply picture dependent on innumerable unique local conditions. Salvage is also an activity in transition, characterized by the disappearance of traditional structures and emergence of new ones.

In 1967, the United States salvage or secondary materials industry consisted of 8,000 companies employing 79,000 people and ringing up sales of $4.6 billion. The industry handled 80 millions tons of metals, paper, glass, textiles, and rubber. This is the "formal" portion of the salvage industry—the dealers, processors, and brokers who accept secondary materials from many sources, sometimes process them, and finally sell them to industrial users.

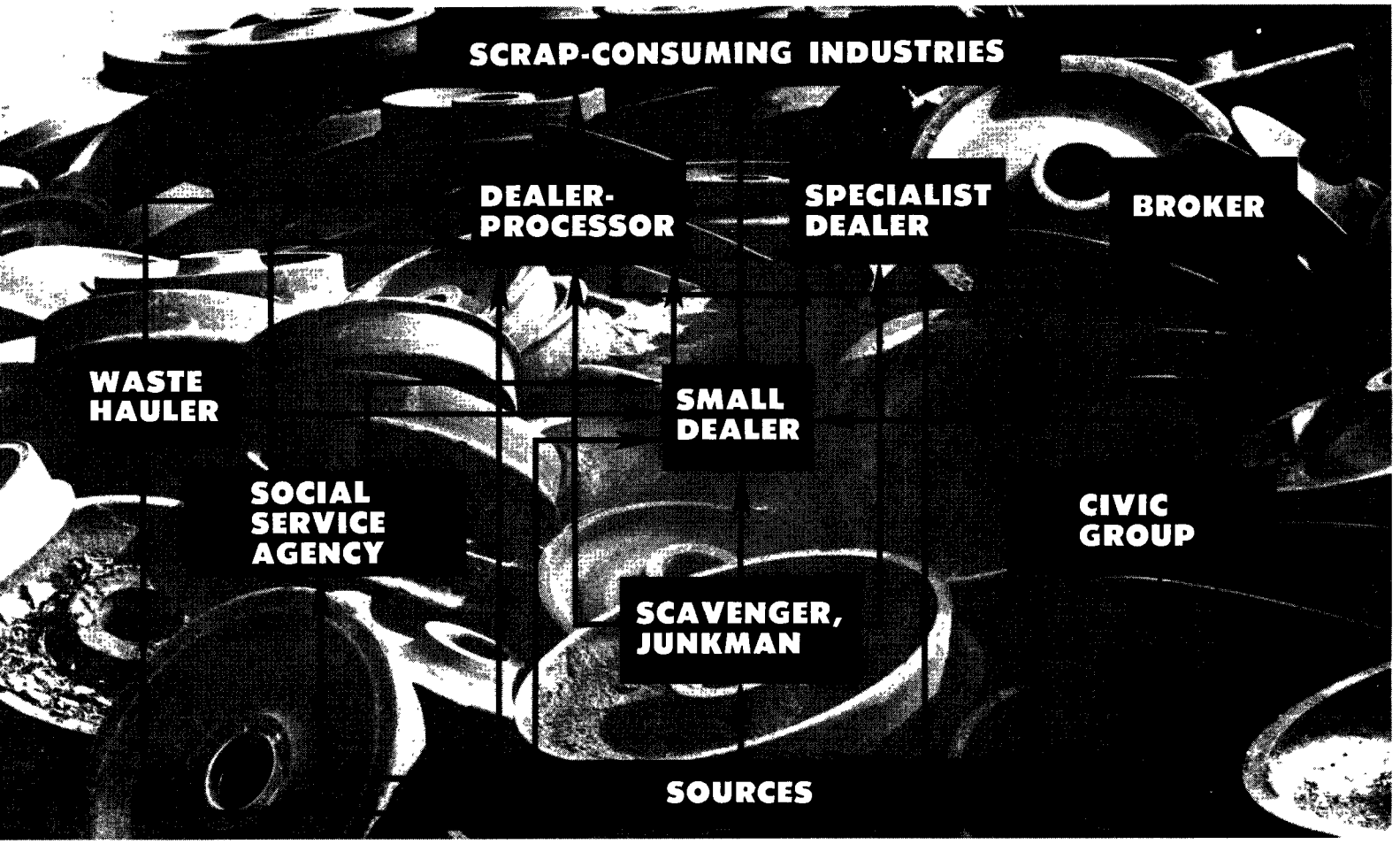
Not all the waste materials recovered or sold pass through the hands of the traditional salvage industry. Most of the glass and much of the metal recycled in the United States are derived directly from the basic manufacturing processes and are recycled without leaving their point of origin. The rendering industry, which accepts organic wastes for reprocessing, is not generally considered a part of the industry. Numerous waste products such as metallurgical slag, fly ash, and rubber tires do not involve junk dealers or brokers.

how the industry is structured

The salvage industry has several identifiable layers. At the bottom is the **scavenger** or **junkman**—an individual who supports himself in part or entirely by picking up waste materials from sources such as small machine shops or printing shops and selling them to secondary materials dealers. The two most important characteristics of the scavenger or junkman are that he is an independent operator and that his participation in the salvage business usually is a part-time activity, and only marginally economical. A special form of the junkman is the small private hauler who segregates salable materials from wastes as they are dumped into his truck, then sells them to salvage dealers from time to time.

The next layer is represented by the

materials flow through many channels in the salvage industry



small dealer who usually handles metals, paper, and textiles. He seldom handles quantities large enough to make it worth his while to develop far-flung contacts with industrial buyers of salvage. He accumulates quantities of materials and sells the accumulation directly to a larger dealer. These small salvage dealers are found in population centers not large enough to support specialized materials businesses, and in industrial centers dominated by large commodity specialist dealers.

Above the small dealer is the **dealer–processor** who usually specializes in either metals, paper, or textiles. He processes and upgrades the wastes before delivering them to the scrap-consuming industries. If he can obtain enough materials from smaller dealers and if the materials are sufficiently processed, he does not actually handle the commodities but merely acts as broker. The salvage industry also includes **brokers** who do nothing but buy and sell commodities.

On the same plane with the dealer-processor and broker is the **specialist dealer** who handles for example, only nonferrous metals or synthetic textiles. His contribution to the salvage industry is his intimate knowledge of a specific commodity and its markets.

Glass dealers and some rubber dealers do not conform entirely to this picture of the salvage industry, probably because only small quantities of these commodities occur in the open market. In essence, these dealers are specialized waste removal firms that sell the wastes they pick up. Glass dealers buy waste glass from bottling operations or flat glass plants, then process it and sell it to a glass manufacturer who remelts it to use in making new glass. Rubber dealers are usually the only link between automobile service stations or garages, where tires accumulate, and the rubber reclaimers who buy old tires.

Intermediate between the junkman and the small dealer are three types of organizations—**waste haulers, civic groups**, and **social service agencies**—that collect commodities and sell them to the salvage industry. These organizations are not normally considered part of the secondary materials industry.

Waste haulers usually service retail stores, warehouses, and industrial organizations that discard large quantities of corrugated board. Civic groups, including churches and schools, may conduct drives, perhaps once or twice a year, to collect waste materials. In the past, newspapers were the chief commodity collected, but cans and glass containers are also now being collected. The materials are sold to a dealer, the proceeds helping to support the sponsoring organization's activities. Wastes also are being collected at recycling centers set up by volunteer groups interested in the environment and in conserving natural resources.

Probably the most extensive collec-

tion activity taking place outside the formal salvage industry is conducted by social service agencies. Organizations such as the Salvation Army and Goodwill Industries are responsible for most of the waste textiles collected in the United States, plus some wastepaper and small quantities of metals. Social service organizations typically pick up usable commodities from residences, then sell them in secondhand stores to help support their charitable and rehabilitative work. Commodities also are collected in bins placed in parking lots of shopping centers.

Some of the goods are beyond repair and are sold as junk or simply discarded as wastes. Social service agencies sometimes compete with salvage dealers in that they sort and process wastes, then sell directly to the end user. As a rule, such agencies pay below minimum wages, either because they are sheltered workshops exempted from requirements of the minimum wage law or because the labor performed is quasi-voluntary.

scrap is not sold, it is bought

An axiom in the salvage industry is that "scrap is not sold, it is bought." The skilled secondary materials dealer is a skilled buyer. Because he sells a substitute for raw materials, he cannot control his selling price. It is determined by demand, which in turn is influenced by general economic conditions and the relative availability and cost of virgin resources.

Demand and price fluctuate—the dealer sometimes may be forced to tap every conceivable source to satisfy demand. At other times, he must "turn off" his poorer sources. If necessary, he will buy from his best sources to protect them during periods when demand is low, in order to retain them as sources when demand is again high.

The successful dealer keeps his in-

ventories low, buying at the appropriate price. He avoids long-range commitments to buy (especially from poor sources) and to sell (unless the sales price is negotiated high enough or is pegged just above a published market price). The skilled dealer "rides the market," buying only what he can sell, selling everything he buys, and keeping a safe margin between his buying and selling prices.

what's good and what's bad

In selecting sources of waste, the dealer considers concentration or purity, grade, and quantity. He shies away from "dirty" scrap. He chooses high-grade wastes, which most resemble virgin materials, over low-grade. He prefers buying in quantities large enough to resell immediately, rather than buying smaller quantities that must be accumulated before they can be shipped. These factors can appear in many combinations. Mixed municipal wastes are a poor source, virtually devoid of concentrations of high-grade commodities. Commercial establishments such as offices, hotels, and retail stores generate wastes similar to mixed municipal wastes, except that commercial wastes contain more paper and less food wastes. Corrugated board and mixed office paper are the only materials salvaged in quantity from commercial wastes. Mixed papers are salvaged only when demand for wastepaper is high.

Wastes from industry represent the bulk of secondary materials traded, and virtually all of the high-grade materials. The salvage industry favors industrial wastes because they are homogenous, of known and consistent composition, and are generated in large quantities on a regular basis. All industrial operations generate waste materials, and plant managers usually try to reuse or sell as much as possible—to produce income, rather than to pay for disposal. For this reason, manufacturing wastes are kept free of contaminants, are processed if necessary, and are accumulated for delivery to salvage dealers.

who buys its wares

Steel scrap, nonferrous metals, glass, and small amounts of newspapers and corrugated boxes are the only secondary materials that are reprocessed into essentially the same products that they were originally. All others enter new industries. Most old newspapers and corrugated boxes become bending board or construction paper. Old tires are converted to material used to retread tires. Old cotton cloth becomes wiping rags. The demand patterns governing the receiving industries are not neces-

sarily synchronized with those of the industries that generated the materials. Thus, an increase in tire production may in fact mean a decline in purchase of retreads.

The products of the salvage industry are bought by two very different kinds of scrap-consuming industries. Distinction between the two is important because it explains much about the nature of salvage and recovery in the United States. The two groups are: industries that use wastes as principal or sole input, and industries that use small amounts of wastes.

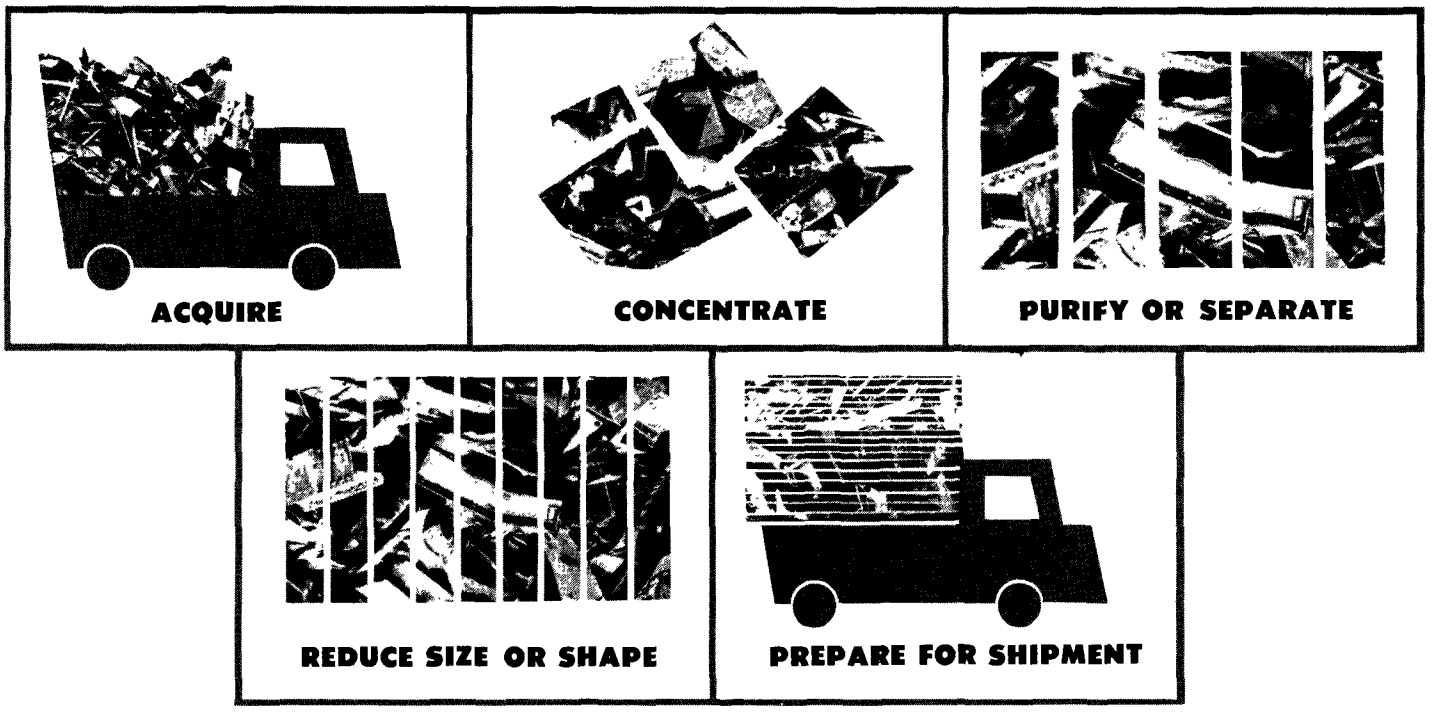
Examples of industries that depend on wastes as their principal or only input are combination-board manufacturers, de-inking mills, roofing paper mills, wool reweavers, electric steel furnace operators, secondary metals smelters, glass producers such as ash tray manufacturers who use only scrap glass, rendering plants, and rubber reclaimers. These industries must obtain secondary materials on the open market, and they are the backbone of salvage demand. Their production rates largely determine how much waste will be recycled. Some secondary materials are used because they are cheaper than virgin materials of equivalent quality. Others are used because the quality of the manufactured product need not be equivalent to that of products made of virgin materials (as in combination board) or because a product of equivalent quality can be made from secondary materials (as in electric-furnace steel).

Examples of industries that use relatively small amounts of wastes are fine-paper manufacturers, operators of basic oxygen steel furnaces, glass container or window glass manufacturers, plastics producers, and tire manufacturers. They use salvaged materials because technical factors sometimes favor their use, because not enough such scrap is generated internally to fill their needs, and because the secondary materials they use are relatively cheaper than virgin raw materials if processing costs are included. It is difficult to generalize about the relative value of virgin and secondary materials when both are used in one operation. Scrap materials are not simple substitutes: They may be required by the process, they may yield special benefits such as prolonged life for furnace linings, they may have to be used because they are a process waste material that would otherwise require disposal, or they may reduce air or water pollution.

how the industry operates

In recovering waste commodities, the salvage industry uses up to five types of operations: acquisition, concentra-

salvage industry performs up to five operations in recovering waste commodities



tion, purification or separation, reduction of shape or size, and preparation for shipment. The sequence in which they are accomplished—or whether they are needed at all—depends on the material itself, as well as on its source, condition, and end use.

The key operation in salvage is sorting. Except for separating out ferrous metals magnetically, sorting is done manually and so is very expensive. Even magnetic sorting is not possible where the ferrous metal and some other material are mechanically or chemically coupled.

Technology is being developed to overcome the problems of sorting mixed municipal wastes. The Environmental Protection Agency has provided funds to help demonstrate several different systems in full-scale plants. One system adapts paper pulping technology to produce a saleable paper pulp product, metals, and glass. Another system separates metals and glass from incinerator residue, using various materials-handling techniques developed in the mining industry. Four systems approach the problem of sorting from a different angle, burning the combustible materials of municipal wastes, and using the heat produced. Still other systems are being studied but have not progressed far enough to be demonstrated in full-scale plants.

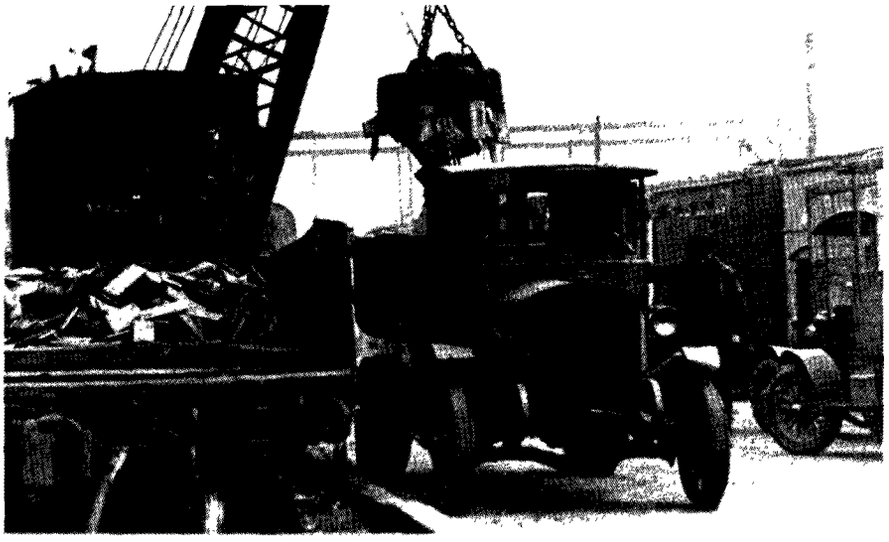
operating costs are high

The costs of obtaining and processing secondary materials are high, especially when related to the price they bring in the marketplace. Operating economics are most unfavorable for those materials that occur in large quantities in waste—mixed paper, metals, and glass. Not only is demand limited, but these materials also bring the lowest prices, and processing costs are higher than for better grades of scrap materials. If the material must be sorted from mixed municipal wastes, costs become even higher.

Glass is a good example. In mid-1970 the sand, soda ash, and limestone used to make glass cost $15 to $20 per ton. The glass industry estimates that the benefits of using scrap glass in the furnace, instead of virgin raw materials, are worth $2 per ton. Therefore, to be economical, scrap glass should cost no more than $17 to $22 per ton. Instead, the delivered cost was $29 to $36 per ton for scrap glass recovered from mixed municipal wastes:

$13 to $15	for manual sorting
$14 to $18	for pickup and processing
$ 2 to $ 3	for delivery
$29 to $36	

It is hardly surprising that glass recovery programs involving pickup from residential sources must be subsidized. The same generally holds true for all materials categories, if the materials must be removed from mixed wastes by present techniques.



PHOENIX QUARTERLY

Long before the present national interest in ecology and recycling, the scrap-processing industry was at work preparing metallic cast-offs for remelting by steel mills and foundries.

Transportation is another important cost consideration in the economics of salvage. The ultimate value of the material determines the relative distance it can be transported. Most salvaged secondary materials are consumed no more than 500 miles from where they originated. Materials with high value—nonferrous metals and wiping rags, for instance—can travel 1,000 miles or more, but nearly all low-value materials—newspapers and scrap glass, for instance—are sold within 75 miles.

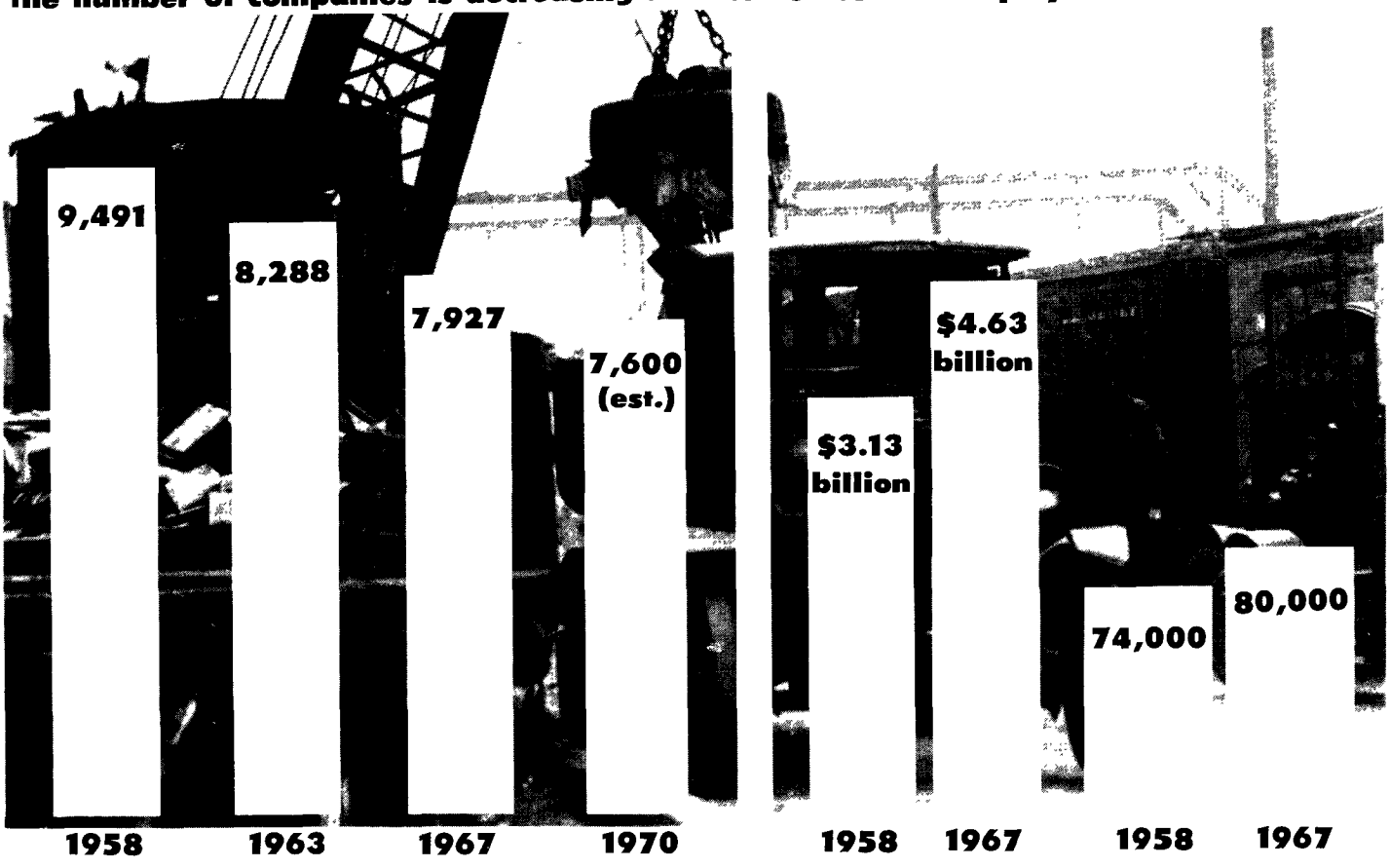
some hidden costs

The economics of salvage can be hard to understand unless some hidden aspects are kept in view. The most significant aspect is that if waste materials can be salvaged, they don't have to be disposed. A salvage operation costing $15 per ton and returning $10 is not, on the face of it, economical. Yet it may be practical if disposal costs $6 per ton.

The second aspect of salvage economics is that salvaged materials often ride "piggyback" on a system devel-

salvage industry is centralizing

the number of companies is decreasing . . . but sales and employment are increasing



oped for other purposes. An example is the collection of waste textiles from residential sources. By collecting door-to-door, social service agencies get commodities such as usable furniture from which they may be able to realize profits equivalent to several hundred dollars per ton. The high income justifies collection costs of $80 to $90 per ton. Waste textiles also are picked up, but they seldom earn the agency more than $50 to $60 per ton. Thus, collecting salvageable materials alone would not be economical, but it is when they ride free with more valuable merchandise. Another example of the same principle involves trucks that carry merchandise from warehouses to grocery stores. Normally, the trucks would return empty to the warehouse; instead, they carry corrugated boxes back to the warehouse, where large enough amounts accumulate to make their salvage profitable to management.

The third special economic consideration related to salvage is that the recovery of some classes of material is indirectly subsidized by:

- Voluntary contribution of labor, time, and transportation by neighborhood recycling centers or school-sponsored paper drives.
- Employment of physically or socially handicapped persons who receive below-average wages from social welfare agencies.
- Efforts of people on the margins of economic existence who salvage commodities as an alternative to welfare and who neither pay themselves an average wage nor count all of their real costs (the use of a car or truck, for example).
- Sloppy accounting by some secondary materials dealers and processors who do not account for all the costs they incur, especially not amortization of equipment.

If these hidden subsidies were eliminated, recovery of most textiles, newspapers, and portions of all other recovered materials would become uneconomical. These points should be kept in mind whenever a salvage program is contemplated that would duplicate an existing system. If the new system does not enjoy the same subsidies, it might be economically unfeasible.

trends and development

The salvage industry is changing in a number of ways, perhaps the most important being that it is centralizing. The number of companies has decreased since the 1950's, while industry sales and employment have increased. The trend toward bigger companies is in part a result of economic and technological pressures. The coming of minimum wage legislation has made labor-intensive operations of acquiring and sorting wastes more expensive. To remain competitive, salvage companies have had to use technology to increase labor productivity, just as processors of virgin materials have done.

In the ferrous scrap business, the pressures have resulted in the invention of large metal shredders which reduce automobile hulks into fist-sized pieces of metal that can be separated magnetically into ferrous and nonferrous portions. These shredders are working a revolution in the scrap business. They permit upgrading a plentiful source of scrap, auto hulks, so that they sell for $31 to $36 a ton, instead of $19 to $24 for unshredded hulks. To use a shredder efficiently, however, a scrap dealer must have sales of about $500,000, and preferably well above. To achieve this volume, scrap dealers have had to merge or acquire other companies to tap new scrap sources and outlets.

In the scrap paper business, the single most important innovation has been the high-density baler. Such machines cost around $120,000 and can handle 30,000 tons of paper per year. They reduce freight costs as much as $5 per ton on trips of 500 miles, they make the paper easier to handle, and they provide a better product to the user. As of mid-1970, only a few were in operation. To use one efficiently, companies must have sales of about $600,000 annually, and, again, centralization is occurring to permit taking advantage of new technology.

In the textile salvage industry, economic pressures have taken four basic forms:

- Overseas sales of waste textiles are declining.
- Labor costs are rising.
- Percentage of pure cottons in waste textiles is decreasing.
- Paper and new nonwoven fabrics are gaining ground in the markets for wiping rags.

Instead of combining with stronger dealers, textile salvage dealers are going out of business. The same situation prevails in other waste materials, and the numbers of companies dealing in glass, rubber, feathers, hair, bone, and other wastes have decreased drastically.

Another trend working to the disadvantage of the salvage industry is that the ratio of scrap materials consumed to total new products made has been declining in nearly all basic manufacturing industries. As a result, relatively more scrap is available than is needed. The industries consuming scrap materials can be far more selective in their purchasing. They can and do insist that secondary materials be of higher quality.

At the same time, the obsolete products and the wastes from industrial operations that make up the salvage industry's resources are generally becoming more contaminated. Base materials such as steel, paper fiber, wool, cotton, rubber, and glass are being combined with materials that are incompatible with the operations of the raw materials processor. To provide the raw materials processing industry with pure scrap, the salvage dealer must choose his sources more carefully, or he must do more processing, which favors larger dealers with the capability to invest in technology.

SALVAGE AND SOLID WASTE MANAGEMENT ORGANIZATIONS

Until quite recently, solid waste management organizations viewed salvage as a nuisance that interfered with their principal purpose: to collect and dispose of waste materials efficiently and in a manner that protected the public health and the environment. In 1968, the organizations handled almost 194 million tons of municipal wastes. The tonnages were about equally divided between public forces and private companies. This service cost the Nation $3.5 billion annually, or $1.1 billion less than the salvage industry's sales.

The job of collecting the Nation's municipal wastes is big—and it's getting bigger. The population is growing, and each person is consuming more goods and so is discarding more wastes than before. Furthermore, new air pollution regulations ban open burning. Wastes that once were burned in backyards must now be collected and disposed of.

In the past, many solid waste management organizations attempted to salvage commodities from municipal wastes, but today the only large-scale salvage practiced by public agencies is recovering steel cans from incinerator residues—and that is done by only a few communities. In addition, some dumps permit scavenging.

Public solid waste management organizations gave up on salvage because they found they couldn't sell the commodities at a profit. It proved simpler to pick up, transport, and process a single mass of waste than to split it into two or more streams, each requiring specialized treatment techniques, management and labor skills, collection and distribution networks, markets, and ultimate disposal arrangements. As the waste management process has been streamlined, marginal activities that interfere with the rational organization of the system have been eliminated.

The current attitude toward salvage is not solely a result of the decline of markets. A number of other developments since World War II have pushed or enticed waste disposal agencies in the direction of simplified and efficient practices:

- Introduction of the compactor truck, which permits carrying larger loads, but prohibits salvage because wastes are mixed together and contaminated.
- Public resistance to segregating wastes prior to collection.
- Increase in kitchen garbage grinders, which divert organic solid wastes into sewers, and concomitant decrease in using wastes for animal feed. When

public health considerations dictated that garbage had to be cooked before it could be fed to animals, a new cost was introduced that closed down virtually all feeding lots based on garbage.

• Growing use of sanitary landfilling. Scavengers who were welcome at open dumps are unwelcome at sanitary landfills, where their presence interferes with efficient and safe operations.

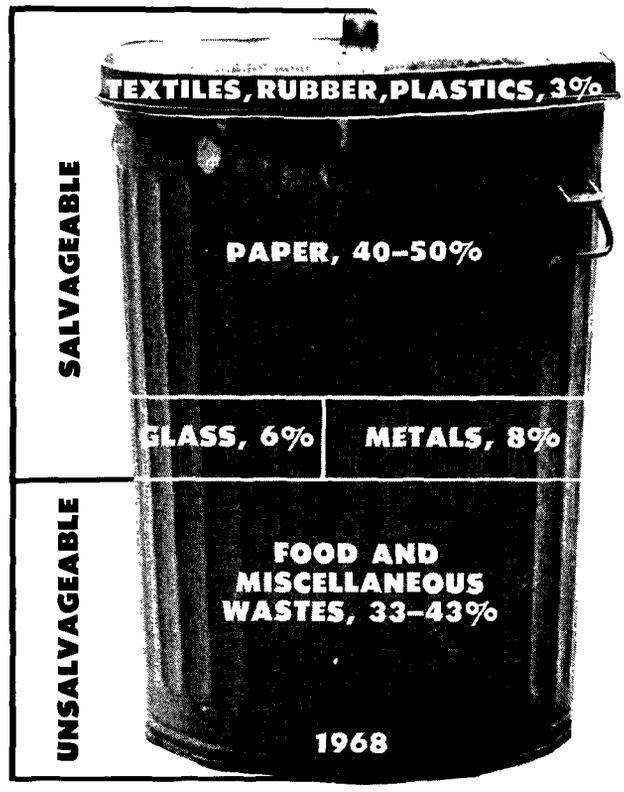
Today, salvage must show an overwhelming advantage before it is considered by the more efficient and well organized solid waste management agencies. Financial incentive is not enough. Income from a small percentage of the waste is readily sacrificed if it impedes disposal of the bulk of the waste.

Municipal waste management practice, characterized as it is by bureaucratic regularity, presents a poor fit to the usually roller-coaster operation of the salvage business, where supplies

a quarter of major manufactured materials are salvaged

1967-68 Material	Total consumption (million tons)	Total recycled (million tons)	Recycling as percent of consumption
PAPER	53.110	10.124	**19.0**
IRON AND STEEL	105.900	33.100	**31.2**
ALUMINUM	4.009	.733	**18.3**
COPPER	2.913	1.447	**49.7**
LEAD	1.261	.625	**49.6**
ZINC	1.592	.201	**12.6**
GLASS	12.820	.600	**4.2**
TEXTILES	5.672	.246	**4.3**
RUBBER	3.943	1.032	**26.2**
TOTAL	191.220	48.108	**25.2**

over half of municipal wastes consist of salvageable commodities



must be "turned off" one day and "turned on" a month later. City officials have learned by experience that salvage dealers are not "reliable" buyers of scrap.

In the wake of Earth Day 1970, however, public officials are beginning to change their attitudes toward salvage. The growing Federal interest in resource recovery, as well as industry's efforts to find ways of reclaiming materials, is making public officials take a second look at salvage. Another factor is that public officials are coming to view salvage as a way of conserving scarce space in sanitary landfills.

Private waste companies generally share the attitudes of public sanitation officials, but they are quicker to react to the economic incentives in salvage. Private haulers handle more commercial wastes than do public agencies, including sources rich in corrugated paper; their salvage activities, if any, usually involve corrugated.

SALVAGEABLE COMMODITIES IN MUNICIPAL WASTES

In the 1967–68 period, 191 million tons of the major manufactured materials —paper, metals, glass, textiles, and rubber—were consumed yearly. In the same period, 48 million tons of these same materials—about 25 percent—were recycled through the market annually.

Recycled materials generally come from either fabrication wastes or obsolete discarded products returned to industry for reprocessing. Almost no materials are salvaged from municipal wastes, although over half (by weight) of such wastes are salvageable.

paper

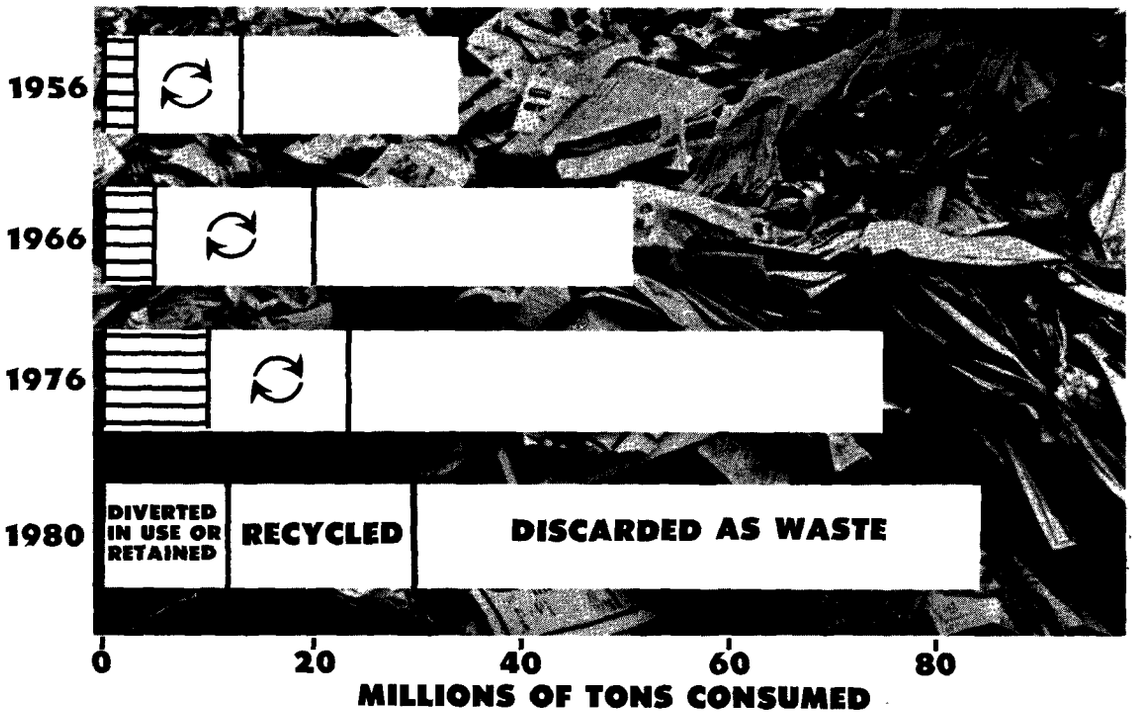
In 1969, the United States consumed 58.5 million tons of paper—more than 12,000 kinds in over 100,000 finished forms. Paper consumption has almost tripled since 1945 and is expected to continue to increase. By 1980, the United States should be consuming 85 million tons annually.

Unlike steel products, which have an average life of 20 years, most paper is used and discarded in the same year it is purchased. Its value is low in comparison to its bulk, so most discarded paper products enter the waste stream. Paper is the largest component —40 to 50 percent by weight—of municipal wastes collected in the United States. Once in the waste stream, almost none is salvaged. However, paper is salvaged before it gets into the stream—principally discarded paper products and scrap produced when paper is converted into finished forms such as envelopes or boxes.

While consumption of paper has increased in recent years, the percentage recycled has decreased. In 1969, only about 17.8 percent of the paper consumed in the United States was recycled paper, versus 27.4 percent in 1950. The result is that paper is an ever-increasing burden on solid waste systems.

Making paper starts with harvesting wood from trees and converting it to pulp in pulp mills. The pulp is then converted in paper mills to the basic kinds and grades of paper. Paper mills can also use wastepaper; generally, it is converted into cheaper types of paper than it was originally. The last step is to convert paper into finished forms. These various steps can be aligned in a number of ways—ranging from the large integrated operations that grow trees and sell envelopes to an independent pulp mill that merely

paper is increasing in municipal wastes



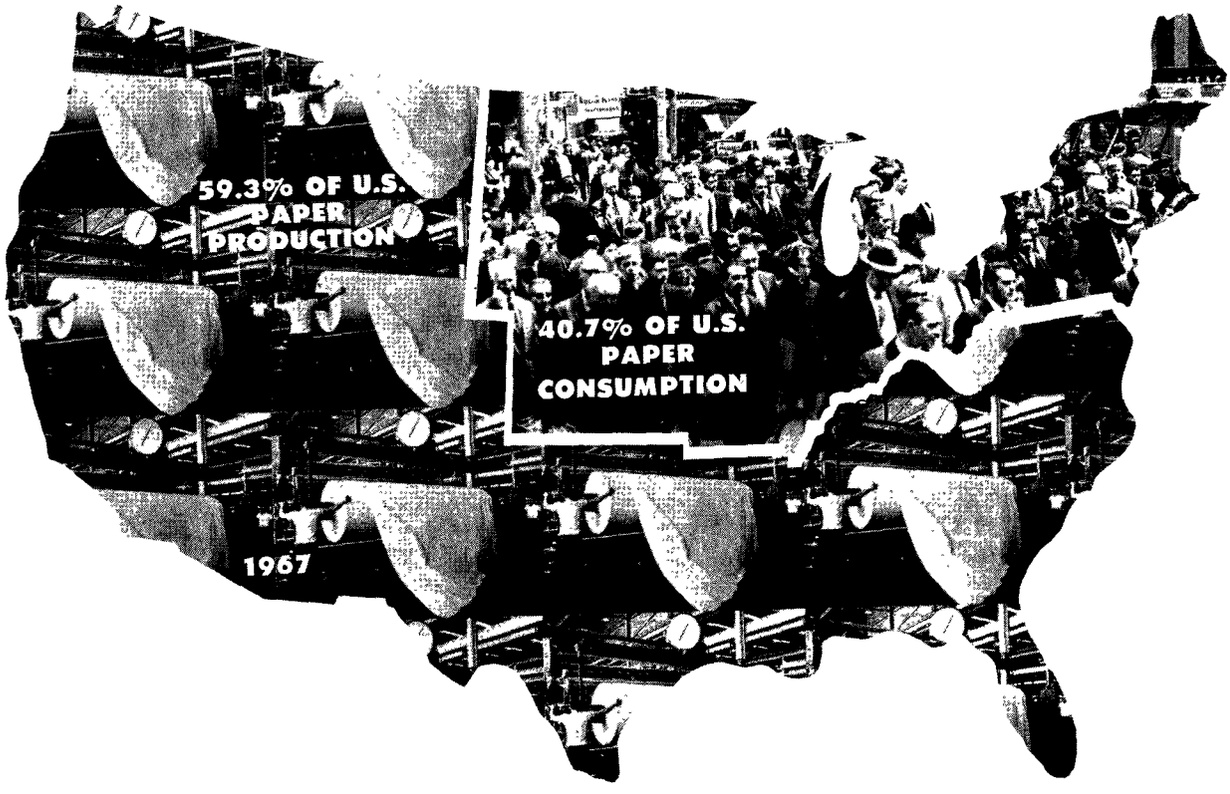
makes pulp for sale.

Today, the U.S. paper industr dominated by the large integ operations. Most of the plants inst since 1945 have been based on pulp and located near virgin raw terials, primarily in the South anc West, rather than close to popul centers where paper is consumed later discarded. Using improved v pulping technology, the industry tapped abundant raw material costs low enough and in quan large enough to meet rising dem for paper. Only very recently has technology for wastepaper begu catch up.

Most of the paper now recycled into making paperboard, the forms of paper used primarily to boxes. Small amounts are used i other major types of paper produ construction materials (such as r felts) and paper itself.

The demand for products made dominantly of waste, or secor

paper production facilities are located away from population centers where waste paper is discarded



fibers has lagged in recent years for three reasons:

- Products made mostly of wastepaper tend to increase at a lower rate than other paper products and are losing markets to competitive materials such as plastics.

- Wood pulp has taken over some markets—packaging, for example—from wastepaper as industry has upgraded its products to improve appearance and to achieve higher "purity," even when performance of the product did not require upgrading.

- Wastepaper has penetrated only one new market in recent years—newsprint.

Wastepaper for recycling comes from these major sources: corrugated boxes collected from stores, newspapers collected mostly from homes, and wastes from paper converters.

Newspapers are one of only two materials commonly found in municipal waste that are still salvaged in quantity. The other is textiles, which are either resold or diverted into secondary uses. These materials are segregated before collection, and in a sense have never been part of the solid waste stream. The mixtures of other paper products found in the family garbage cans are not good candidates for recycling as they are. Even if they could be segregated, they would be difficult to salvage as commodities.

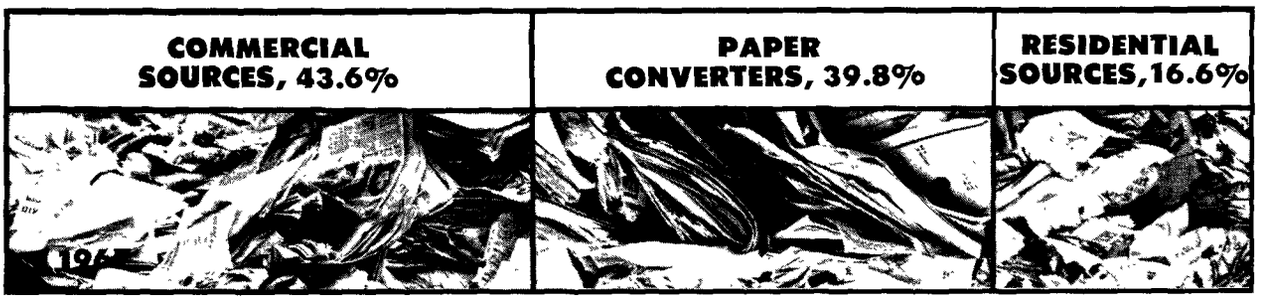
Almost anything added to paper, either intentionally or unintentionally, in large quantities or small, destroys its value as wastepaper because of the cost involved in removal. The paper for "slick" magazines, for example, is coated with clay. Although clay is easily removed, it can cause water pollution, and it also represents 30 percent or more of the weight of the paper. Plastic coatings and adhesives must be removed before paper can be recycled. There is no economical way of recycling laminated paper, such as is used in some frozen orange juice cans.

The fundamental problems are those of accumulating "pure" grades and of fighting low levels of contamination. The progressive contamination of fibrous materials in the converting/consuming cycle work against recycling of paper. In contrast, making paper from virgin pulp is a process that progressively upgrades fibers.

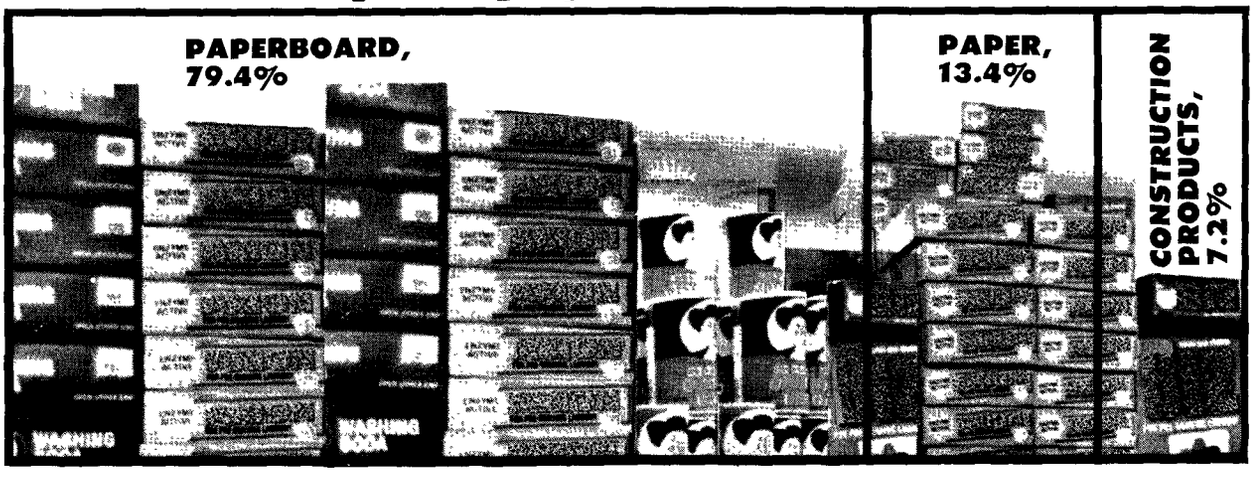
Still, considerable quantities of paper can be recovered from products commonly found in municipal wastes. From 5 to 10 million more tons of newspapers and corrugated board could be recovered by time-honored techniques. An equal amount of mixed paper, none of which is now recovered, might even be recovered—either by asking the public to voluntarily segregate it or by using new technology to separate it and then upgrading the recovered product so it will be competitive with existing raw materials.

It is technically feasible for the paper industry to absorb additional quantities of wastepaper. But to do

paper for recycling comes from . . .



recycled paper is used in . . .



so, it will have to idle large portions of its equipment for pulping wood. This would require a large drop in the price of wastepaper, a high tax on use of virgin pulp, or equivalent changes that would make wastepaper fiber as cheap as pulp.

By the 1980's, however, new low-cost, readily-available pulpwood lands may all have disappeared. Then virgin prices will rise, and industry may turn to wastepaper out of necessity. But for now, the industry is oriented to pulp. Its plants are principally located close to forest sources, and the economics of using more wastepaper are unattractive.

ferrous metals

The iron and steel industry in the United States uses large quantities of scrap metal in its operations. In 1967, it purchased 33 million tons, which represented almost a third of the metals it used during the year. In addition, 7.6 million tons of scrap were exported.

Of the 33 million tons of scrap the industry purchased, 11.6 million were supplied by fabricators of steel products. The remaining 21.4 million tons were obsolete scrap. Almost no ferrous metals were recovered out of municipal solid wastes, although they constitute about 7 percent by weight of the municipal wastes collected in the U.S. In addition to the scrap it purchased, the industry used 52 million tons of scrap generated internally. Use of this "home" scrap has increased in the past few decades, at the expense of obsolete scrap.

The relative amounts of scrap and pig iron the industry uses to make steel have shifted in recent years because of shifts in the kinds of furnaces being used:

- Open hearth furnaces, which process 41.7 percent of scrap in their metallic inputs, produced 50 percent of total steel output in 1968, down from 87 percent in 1960.
- Basic oxygen furnaces, which process 29.2 percent scrap, produced 37.1 percent of total output in 1968, up from 3.3 percent in 1960.
- Electric furnaces, which process 97.9 percent scrap, produced 12.7 percent of total output in 1968, up from 8.4 percent in 1960.

The rapid rise in the basic oxygen furnace has meant a slight decrease in the industry's use of scrap (down from 47.8 percent in the 1947–53 period to 43.4 percent during 1964–68). This decline will not necessarily continue indefinitely. What is more likely to happen is that as demand drops, scrap prices will drop, basic oxygen furnaces will be modified to permit using more scrap, and more electric furnaces will be installed.

Scrap is used in steel furnaces as a relatively inexpensive source of iron. Except in electric furnaces, where the input is almost entirely scrap, it is not a direct substitute for pig iron.

scrap satisfies almost a third of the iron and steel industry's demand for metals

Rather, scrap is used to achieve best technical operations. But much of the scrap input is generated internally and must be used if industry is to avoid severe losses of its metals.

About a quarter of the obsolete scrap used by the steel industry comes from automobile wreckers and railroads. A host of other sources (including demolition projects, farms, and shipbreaking) account for the remainder. Steel makers prefer home scrap because they know exactly what it contains, although scrap from fabrication plants is almost as good. Steel from demolition of buildings, ships, railcars, and other structures is high quality scrap because its composition can be readily ascertained. Shredded automobile steel, if all nonferrous metals and nonmetallics are removed, also falls into this category. Least desirable is mixed scrap of unknown origin, which includes burned auto bodies and metals derived from municipal wastes.

Ferrous metals occurring in municipal wastes consist largely of tin-coated steel cans, which are not suitable for recycling in steel furnaces. The tin coating cannot be removed and contaminates the furnace products. Tin-free steel is slowly coming into use, so—technically at least—recycling of steel cans is becoming more feasible.

The small tonnages of ferrous metals recovered from municipal wastes are usually in two forms—massive pieces removed from incinerator residues or retrieved from dumps or landfills, and steel cans recovered from incinerator residues and sold to copper mines in the west. About 300,000 tons of scrap cans and wastes from can manufacturers are used annually at the mines to recover copper from low-grade ores. This market may triple over the next decade, but it is still a limited one. Large quantities of wastes in concentrated form are available from can manufacturers, and the cost to transport scrap cans from population centers to the mines is high. Therefore, reusing a large percentage of obsolete cans in copper mining does not appear to be a practical solution.

In general, ferrous metals are recycled at a fairly high rate—but still far below the potential supplies available and the amounts the industry could recycle. More ferrous scrap will be consumed only when its price becomes more competitive with that of virgin raw materials. As in the case of paper, this will require intervention in the normal market forces.

nonferrous metals

The major nonferrous metals—aluminum, copper, zinc, and lead—constitute less than 1 percent of collected municipal wastes. In 1967, nearly 9.8 million tons were consumed, of which 3 million were provided by recycled materials, for a composite recycling rate of 30.8 percent.

All these metals are valuable as scrap. In contrast to steel, which was selling for $130 per ton in 1967, their prices ranged from $277 per ton for zinc to $754 for copper. Their composite value in 1967 was $517 per ton. As waste they usually appear in small quantities and in combination with other metals. But their high value permits relatively more processing than is normal with other wastes, as well as acquiring smaller quantities.

Copper, zinc, and lead are in short supply worldwide. Their high rates of recovery—particularly copper and lead—are a reflection of this shortage, and their recovery rates are expected to continue to climb.

Copper for recycling comes from both industrial wastes and from obsolete products. Only small amounts are found in municipal wastes, in the wiring of household appliances. It is no longer economical to strip and collect this copper. Most obsolete copper scrap comes from demolition of electric utilities, spent cartridges, railroad car dismantling, and automotive radiators.

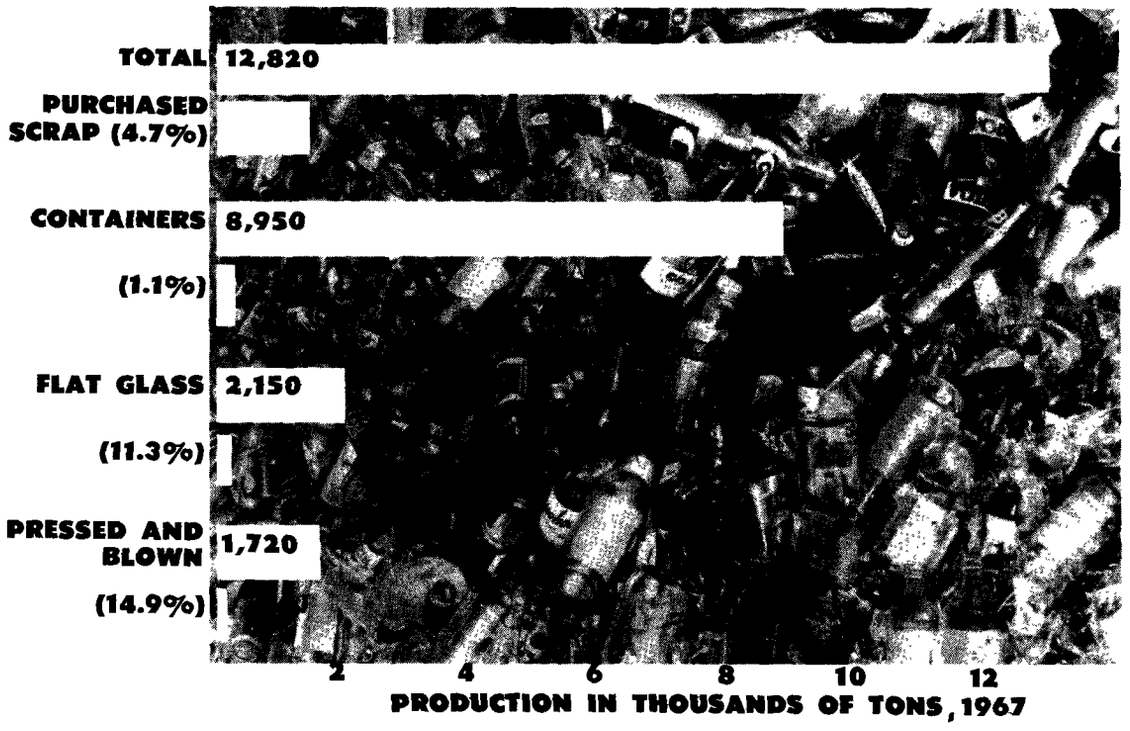
Nearly 80 percent of all zinc recycled comes from processing and fabrication wastes. The relatively small amounts recycled from obsolete products is explained by the fact that zinc is used as an alloying agent, a coating, and as small objects and fixtures. All make recycling difficult.

Recovery of lead is unusual in that most scrap comes from one discarded consumer product, the storage battery. More than 90 percent of the lead used in batteries is recovered.

The only nonferrous metal occurring in significant quantities in municipal solid wastes is aluminum, principally because it has become an important container and packaging material. Of the scrap the industry purchased, about 80 percent came from fabrication wastes, the remaining from obsolete sources. About two-thirds of the scrap is remelted by secondary smelters, largely for use in castings.

Unlike the situation in the steel industry, where scrap and pig iron do not compete on an equal basis, scrap aluminum in the form of secondary ingot competes directly with primary ingot in the nonintegrated segment of the aluminum industry. Secondary ingot cannot be used in applications where a high level of purity is required. However, it has the advantage of being cheaper. Economics favor secondary aluminum because production of primary aluminum requires large investment in plants. And freight costs are high for primary aluminum because the plants are usually located in remote areas where the

purchased scrap glass represents less than 5 percent of production



necessary large quantities of cheap power are available. The combination of expanding markets for aluminum castings, favorable economics, and ever more abundant supplies of scrap has contributed to a steady expansion of secondary smelting of aluminum.

A new and growing source of scrap aluminum is the reclamation centers set up by aluminum companies. With the proportion of aluminum in municipal wastes rising and aluminum cans such a visible part of litter, the companies reacted to growing legislative pressures by getting involved in reclaiming aluminum packaging. The aluminum industry programs depend on the public delivering the cans to a central collection point where they are processed for shipment to a secondary smelter. Success turns on three points:

- Aluminum is valuable—about $200 per ton at the collection center—and thus is relatively attractive for scrap processing.
- Large enough quantities are brought in so that the collection centers operate economically.
- The public collects the cans voluntarily.

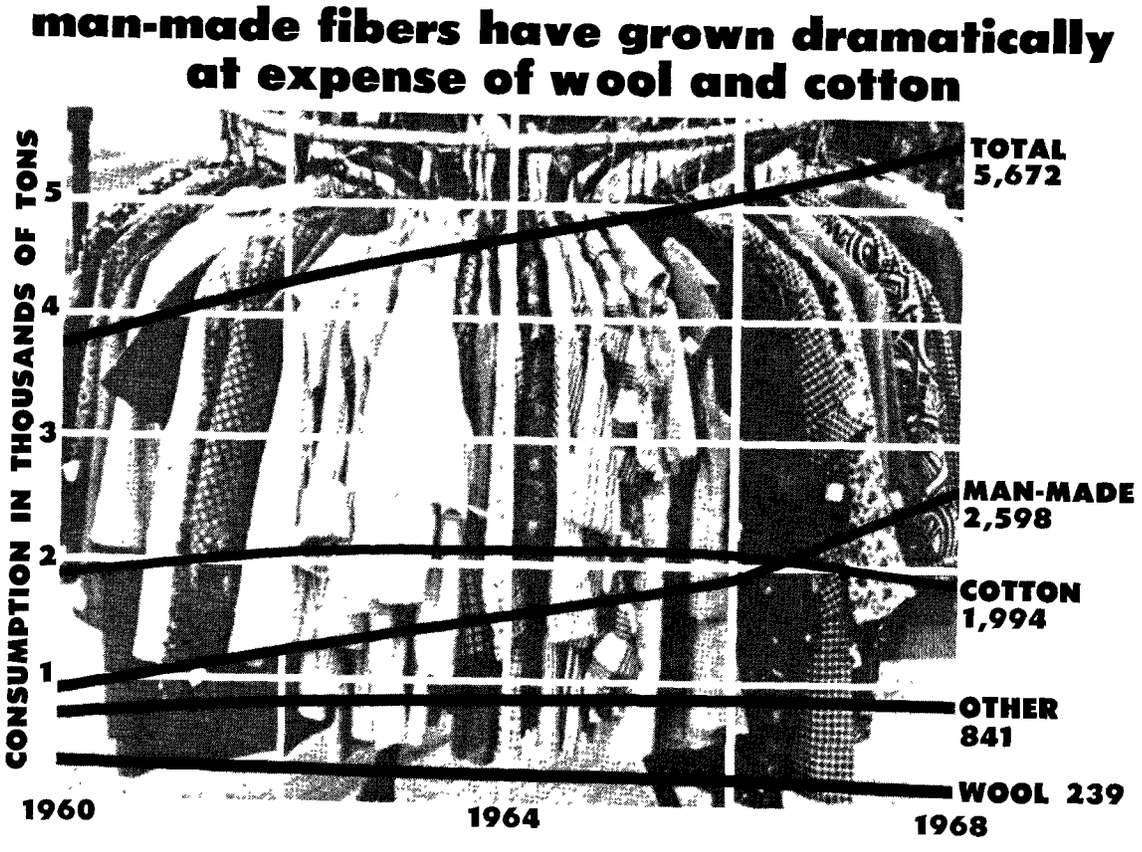
To date, the programs have succeeded in recovering 10 to 15 percent of the aluminum containers available in an area. Ultimately, they might be able to recover as much as 30 percent. There are no technical limitations to recycling aluminum; rather, the problems are in separation and collection. The current aluminum industry programs involve presegregation and special handling. As yet, no company has attempted to tie aluminum packaging and reclamation directly to a municipal waste system.

glass

Glass has an extremely low recycling rate if in-plant scrap is excluded. In 1967, total glass production was 12.8 million tons, of which only 0.58 million tons, or 4.7 percent of consumption, was purchased scrap.

The principal raw materials of glass are sand, soda ash, and limestone (or dolomite). In addition, for technical and economic reasons, nearly every type of glass requires scrap glass, or cullet. It speeds up the melting process in glass furnaces and so reduces fuel costs. The amount of cullet varies, from 8 percent to 100 percent; the average for glass containers is 14 to 16 percent. Most segments of the glass industry could use much more cullet than they do.

The glass industry strongly favors internally generated cullet. Not only is there no question about its composition and quality, but it is cheaper because the basic raw materials are plentiful and cheap. If internal scrap supplies are inadequate, a manufacturer often devotes excess capacity to deliberately producing cullet. Purchased cullet is an unknown quan-


man-made fibers have grown dramatically
at expense of wool and cotton
CONSUMPTION IN THOUSANDS OF TONS
5
4
3
2
1
1960
1964
1968
TOTAL
5,672
MAN-MADE
2,598
COTTON
1,994
OTHER
841
WOOL 239

tity, and its use risks contaminating and hence losing a batch of glass. Most of what little cullet is purchased originates in beer and soft drink bottling operations. Small quantities are purchased from neighborhood recycling centers. In recent years, rising costs and declining sources of good cullet have pushed many cullet dealers out of business.

Containers account for about 70 percent of total glass production, with pressed, blown, and flat glass accounting for the remainder. Essentially the entire output of glass containers is discarded to municipal wastes systems. Glass represents 6 to 8 percent by weight of the materials found in municipal solid wastes—and 90 percent of that is glass containers.

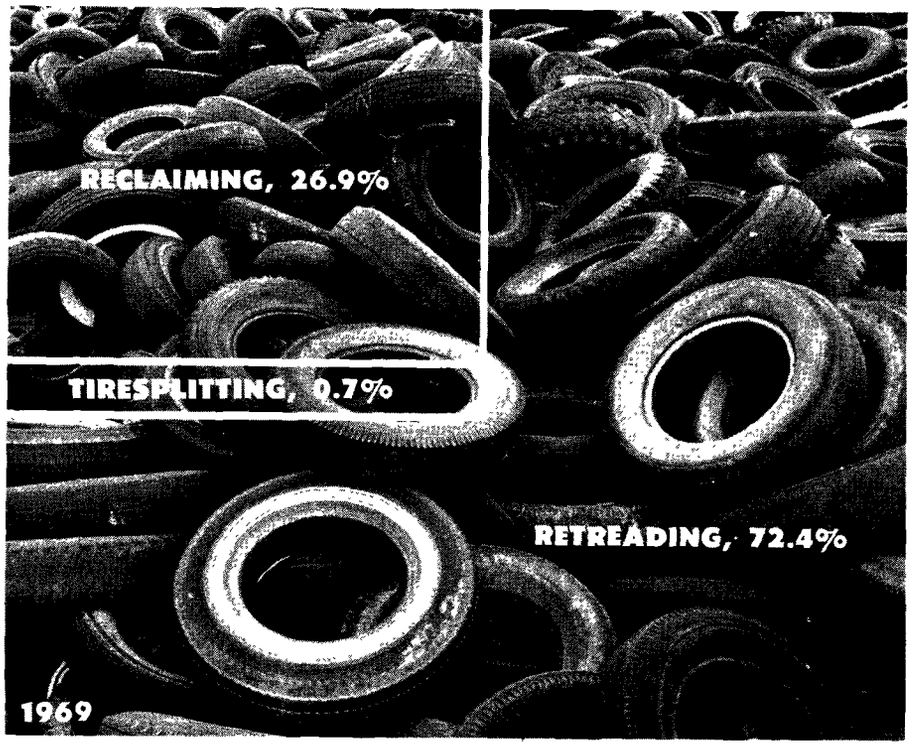
In the last decade, the number of glass containers consumed has increased 5.2 percent a year. Beverage containers have become the dominant type of container, reaching 51 percent on a unit basis of total industry output in 1969, compared to 26 percent in 1959 when the switch to nonreturnable beer and soft drink containers got under way. The other important end use, food packaging containers, is growing modestly, while drug, cosmetic, and chemical container markets have stagnated or are declining. Other materials such as plastic, aluminum, and steel, have been intensive competition for many glass markets in recent years. Thus, the glass container industry's future growth appears to be tied directly to its success in nonreturnable beer and soft drink containers.

textiles

In 1968, nearly 5.7 million tons of textiles were consumed in the United States; 246,000 tons—or 4.3 percent of consumption—were recycled. About 40 percent of total consumption went into clothing, followed by home furnishings, other consumer products, and industrial uses. Consumption of textiles has risen steadily in recent years. The single most significant change has been the phenomenal growth of manmade fibers at the expense of cotton and wool. From holding 24.4 percent of the market in 1960, manmade fibers had grown to 45.8 percent by 1968. The advent of synthetic fibers has been significant not only because they captured markets formerly held by cotton and wool but also because they have reached the market in combination with other fibers, thus making the job of sorting more difficult.

Textile wastes are recovered from operations that convert finished textiles into clothing and other products and from collection of old clothes by social service agencies. Textiles represent only about 0.6 percent by weight of municipal wastes. Very little scrap is recycled back into new textile products. Most textile wastes are either exported (and may then be recycled), converted to wiping material, or reused in making paper and

retreading is principal form of rubber recycling



board products, stuffings, fillings, backings, and paddings. Large quantities of textiles collected from households by social welfare agencies are sold in secondhand stores to reenter the waste stream at a later date.

Recycling of textiles is declining, in part because textile wastes are used in declining rates in paper and board, in part because the use of pure cotton, the most desirable fraction of textile wastes, is decreasing.

rubber

In 1969, 3.9 million tons of rubber (natural and synthetic) were consumed in the United States, about two-thirds of it in the form of rubber tires. About 1 million tons were recovered—26.2 percent of total consumption.

There are three forms of rubber recycling—reclaiming, tiresplitting, and retreading, the principal form. Retreaded tires, however, are losing markets to new tires; this decline is ex-

pected to continue. The decreasing use of retreads is a reflection of growing affluence, competition from synthetic rubber tires specifically designed and priced to be competitive in the retread market, and technical problems within the retreading industry that have increased costs.

About 1 percent by weight of collected municipal wastes is rubber, mostly tires. Though largely rubber, tires are composites of several materials. Removing these other materials and reclaiming the rubber is cheaper than producing virgin rubber, but the savings are not great enough to compensate for the technical limitations of reclaimed rubber. Consequently, rubber reclaiming, which is responsible for 24 percent of all rubber recovered, is declining. With this decline, the rubber content of solid wastes can be expected to rise. Use of waste rubber to produce new materials or energy appears to offer the best hope of recovering the resource values in waste rubber. The technology to do this is under development but it still is unproved in the marketplace. Another problem is the cost of collecting old tires and transporting them to central processing facilities.

plastics

Consumption of plastics has increased dramatically in recent years and is expected to continue to increase. Consumption was 8.5 million tons in 1969 and should reach 19 million tons by 1980. Although plastics were only about 1 percent by weight of collected municipal wastes in 1968, they are increasing rapidly because their use is growing in consumer products, especially packaging.

Large quantities of scrap are produced when plastics are fabricated—as high as 30 percent in some cases. Only a small market exists for fabrication wastes, so that many fabricators haul their scrap to dumps and sanitary landfills. Nor are obsolete plastics recycled. The immense number of different formulations—for example, there are over 700 different grades of polyethylene alone—and the near impossibility of sorting these materials after discard prevent their reuse.

A fundamental obstacle to plastics recovery and reuse springs directly from their synthetic origin. Unlike metals processing, which begins with impure ore and purifies it, plastics processing begins with high purity materials to which new materials are added. A production process based on purification can accept scrap and treat it as though it were partially processed ore. Practical means of removing unwanted contaminants from plastics are still largely nonexistent.

The rapid growth of plastics and the very major barriers to their recovery suggest that plastics in waste may best be used by burning them and recovering the heat. Plastics—largely packaging materials—have the highest heat value of any material commonly found in municipal wastes. Should recovering the heat from municipal waste come into use, the presence of plastics will be beneficial.

POLICIES FOR THE FUTURE

The situation in recycling today is that secondary materials have difficulty competing against virgin materials, which generally cost less. In earlier decades, wastes were not available in large enough quantities to satisfy demand for materials, while virgin materials were abundant. The mining (or harvesting), purifying, upgrading, and processing of virgin materials made dramatic technological and economic strides forward. At the same time, scrap recovery techniques — in the broad sense of acquiring, upgrading, processing, and distributing—remained primitive and expensive.

Virgin materials cost less because the market price reflects only production costs. It does not reflect all the social and economic costs of using virgin materials, nor does it credit recycled materials with the benefits their use creates. Processors of virgin materials enjoy depletion allowances. They do not pay the full costs of the solid wastes generated or the damage done to the environment by their mining, harvesting, transporting, and processing activities. Also, many raw materials—the bauxite ore from which aluminum is derived, for example—come principally from foreign sources, and their use contributes to the Nation's balance of trade problems.

By contrast, secondary materials get no credit for conserving natural resources, removing materials from the solid waste stream, providing materials whose processing usually pollutes the environment less than the comparable processing of virgin materials, and contributing to a favorable balance of trade.

Improved technology can help lower the prices of secondary materials, but more far-reaching changes probably will be required to bring about greater use of recycled materials. Our traditional accounting system will have to be replaced by one based on the concept of resource conservation, where **resource** is defined broadly to include all the substances, energies, manpower, and conditions that we value. A new comprehensive accounting system would consider total costs, tangible and intangible, of producing, distributing, using, and disposing of materials. Under such a system, virgin materials might still be better for some products—it would be clearly undesirable, for instance, to recycle an abundant material if doing so required two or three times more energy, water, and manpower and generated more pollution than in obtaining the same material from natural deposits. But probably more products would be "cheaper" if made from secondary materials.

In the future, we will recycle more of our wastes. As our natural resources give out, we may have no other choice. But if the American people understand the real issues and roadblocks that stand in the way of recycling, they can then support the changes needed—changes in public attitudes, laws, and policies—to bring much closer the day when we stop squandering our natural resources and heedlessly polluting our environment.

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