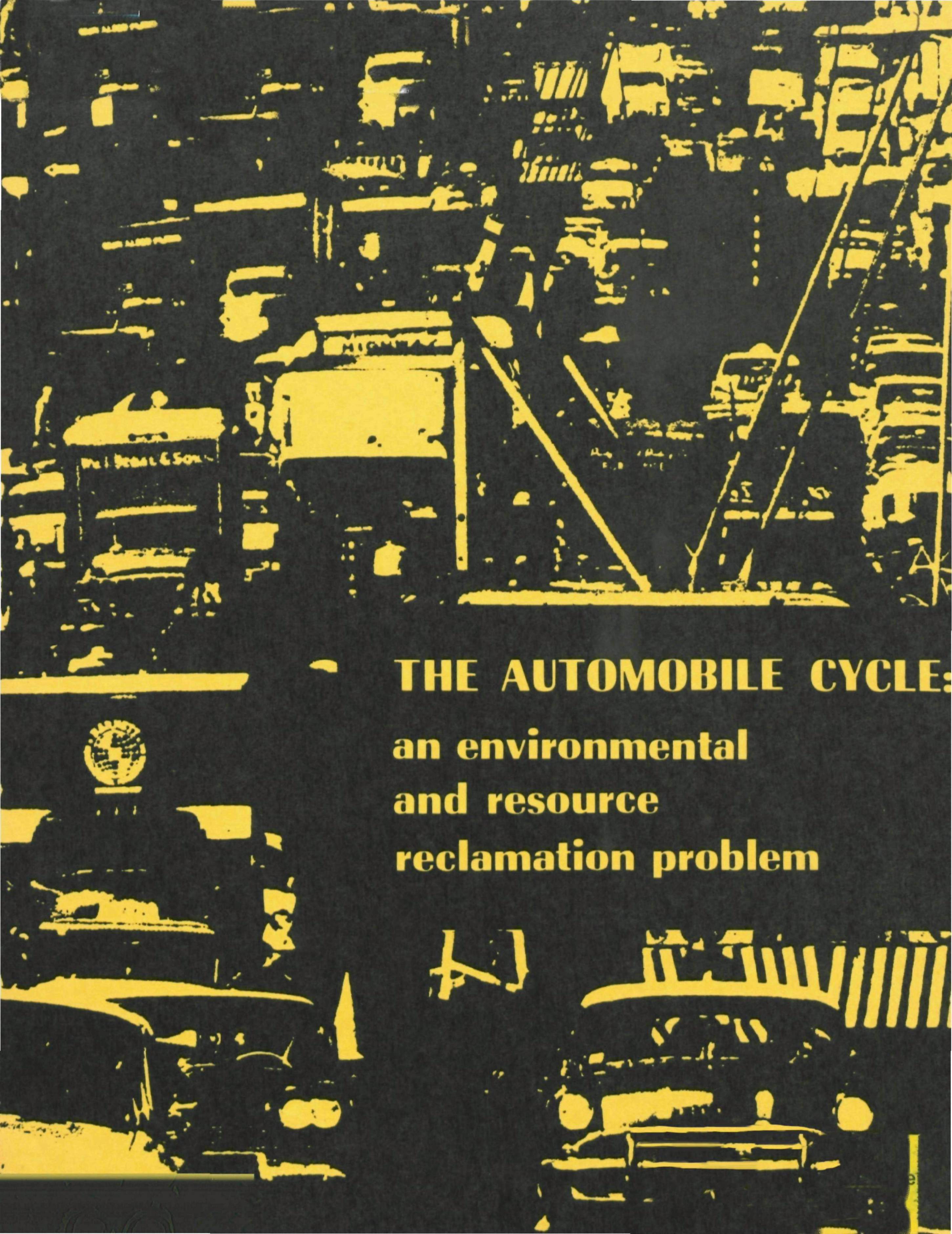

THE AUTOMOBILE CYCLE:

an environmental and resource reclamation problem

THE AUTOMOBILE CYCLE:

AN ENVIRONMENTAL AND RESOURCE RECLAMATION PROBLEM

This document (SW-80ts.1) is a revision of a study made by the Federal solid waste management program for the President's Council on Environmental Quality

U.S. ENVIRONMENTAL PROTECTION AGENCY
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F O R E W O R D

The United States has witnessed remarkable technological advancement and scientific progress during the twentieth century. These advances have stimulated higher standards of living, high-level economic growth, and dynamic changes in a multitude of disciplines. Yet these advances have not proceeded without accompanying difficulties and problems. Technology has not only ensured abundance, but, with its progress, it has also led to a degraded quality of life. Economic and industrial growth have induced changes in the environment with far-reaching and undesirable effects. Residues from our ever-increasing manufacturing production and mass consumption often contribute to environmental pollution, inducing increased concern for problems of air, water, and solid waste management.

The concept of solid waste management in reducing and reclaiming the residuals of a productive society has a twofold benefit: to reduce the quantity and variety of solid waste (or potential resources) requiring handling and disposal and to conserve natural resources and preserve the natural beauty of the environment. It seems, therefore, that a national policy should focus on decreasing the quantity of waste created and increasing the reuse and recycling of secondary materials presently discarded.

More specifically, the fundamental concern of this report is the production-consumption cycle of the automobile industry. The production of automobiles determines both the magnitude and some of the inherent problems of automobile recycling. As automobiles become obsolete and inoperable, they are discarded, abandoned, or returned to industrial processes as secondary materials.

The process of recycling discarded automobiles is, unfortunately, incomplete. For a number of reasons, many automobiles are abandoned along roadsides and on private property and are inventoried by dismantlers and processors rather than placed into the scrap cycle for reuse in iron and steel production. They become, therefore, detrimental to our environment and a waste of mineral resources.

To counteract these problems where the free market has failed, it may become necessary for government to provide incentives to stimulate positive action. To this end, this study was initiated to determine the extent of the problems and to provide a framework by which potential government actions can be effectively evaluated. The techniques are also directly applicable to other similar problems including a large number of complex and interrelated industrial activities.

--SAMUEL HALE, JR.
Deputy Assistant Administrator
for Solid Waste Management

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AUTOMOBILE RECYCLING

The Problem

The automobile, an integral part of our society, has drastically changed man's way of life. With it have come some environmental and natural resource conservation problems that went largely unnoticed from the time of the first automobile until recently. Yet they have become sufficiently acute (and promise to become even worse in the future) to warrant a national effort to alleviate them.

Currently, more than 10 million vehicles are being produced annually, and the number promises to increase at least as rapidly as our population in the future. Unfortunately, automobiles do not function indefinitely, and herein lies the problem. When they cease to function, they are discarded. The discards are only partially reclaimed; the remainder represents a degradation of our physical environment by abandonment on our urban streets and alleys and widespread coverage of our rural landscape. In addition, discarded automobiles represent a valuable resource, which, if used effectively, can conserve our valuable natural resources.

The Approach

The current reuse of discarded automobiles and any attempts at increased use involve a large, heterogeneous, and widely dispersed section of our economy. A large number of interrelated but separate industries operate in, and affect, the automobile scrap cycle. Included are the manufacturer, dismantler, scrap processor, steel mill, and others. Any one of these industries by its current actions or future plans has a large potential for increasing the recycling of disused automobiles. Unfortunately, any one of them can also have a large negative effect on the efficiency of this cycle or even bring about its collapse. Complex interrelationships and interdependencies make the "weak link in the chain" analogy applicable to automobile recycling.

To complicate matters further, dozens of techniques are potentially available to alleviate whatever barriers exist. There are numerous subsidies, regulations, and other incentives that may improve a given industry's strength in the cycle. They may however, have adverse effects elsewhere in the cycle or on the national economy. If a comprehensive and meaningful analysis is to be completed and if recommendations promising a high probability of success are to be developed, a scientific approach is necessary. To date, several detailed studies of the individual industries in the cycle have been completed and limited recommendations made. No comprehensive study has, however, been completed that evaluates all the relevant tactics in the light of the total automobile cycle.

This study presents a comprehensive analysis of the automobile scrap cycle and a scientific evaluation of the tactics and strategies to improve it. The analysis is as follows:

1. A general model of the total cycle is developed to highlight the interrelationships that exist between the major industrial segments. This model facilitates the systems analysis needed later to evaluate strategies.
2. Each major segment of the overall model is studied separately. A detailed flow and process chart is developed to define the scope of operations and delineate the currently available technology in each major area.
3. A decision-logic approach is integrated with the flow charts. This delineates the decisions made within each major industrial segment.
4. All the key decisions affecting recycling in each industry segment are noted and the barriers to favorable decisions are enumerated. This information would be used in the evaluation of tactics and strategies.
5. Some possible tactics for improved recycling are discussed (Appendix A).
6. A method for selecting the best course of action is discussed.

The Model

The automobile cycle is composed of many interrelated activities, most of which are readily definable industries. The major relationships of these subactivities are shown (Figure 1). Starting in the upper lefthand corner of the figure are the automobile manufacturers. They

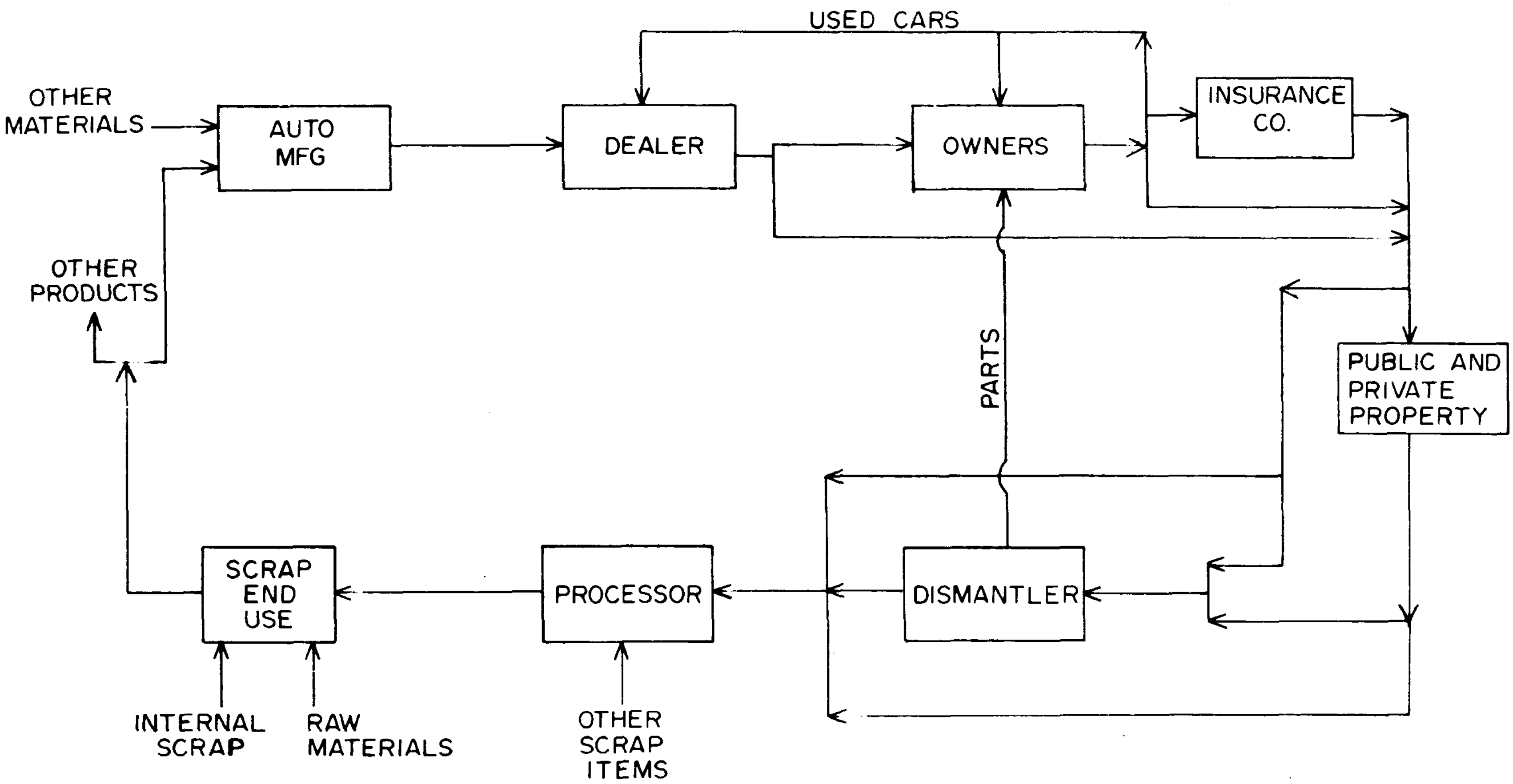

Figure 1. Major relationships in the automobile cycle.

use many raw materials, including steel, to produce a variety of motor vehicles (cars, trucks, and buses). This major industry segment is closely interrelated with dealers, whose primary function is to market and service new as well as used automobiles for owners. The owner's automobile enters the remainder of the cycle in two main ways: through an accident that makes the car unrepairable or through physical, technological, or psychological obsolescence. When this occurs, the automobile is either abandoned on public or private property or is placed into the recycling sequence shown in the lower half of the figure. Generally, recycling is accomplished by a dismantler accepting automobiles from consumers, local governments, insurance companies, etc., and stripping them of useful parts for resale. The residues, commonly called hulks, are then transported to scrap processors for final preparation before delivery to scrap users. The processors take stripped hulks from the dismantlers as well as whole vehicles from other collectors and, in some cases, from consumers. These hulks and vehicles are then subjected to one or more processes designed to facilitate their reuse by the steel and foundry industries. These industries are represented by the box labelled "scrap end use" in the lower left-hand corner of the figure.

These scrap users combine automobile scrap with raw or pelletized ore and other scrap available to them internally or from scrap processors to make iron and steel products. These products can be used for automobile-related products as well as for an almost infinite number of other products.

The boxes shown represent the most readily separable and definable elements in the automobile cycle. Although major industrial segments are definable by these boxes, there are overlaps in many cases. The functional breakdowns shown in the figure are used, even though at a given physical site two different functional activities might be performed.

The model shown is repeated with the addition of the key study areas for this analysis (Figure 2). The five areas shown not only represent definable functional activities and industries but also allow us to pinpoint the key problems associated with the automobile cycle.

Area 1 represents the automobile industry which, by its level of production, implicitly determines the magnitude of present and future recycling problems. In addition, its decisions on durability, composition, and design greatly affect later industrial segments. The problems, barriers, and costs incurred by dismantlers, processors, and end users are all in part determined by decisions of the automobile industry. Hence, the need arises to evaluate this critical segment separately. (The dealers, consumers, insurance companies, etc., represent only the lag between time of manufacture and time of final disposition and as such are not analyzed separately.)

Area 2 represents the critical interface between the final owners of vehicles and their orderly and efficient transportation into the recovery industries. It is here that abandonment, and the degradation of our environment that it implies, takes place. It is in urban as well

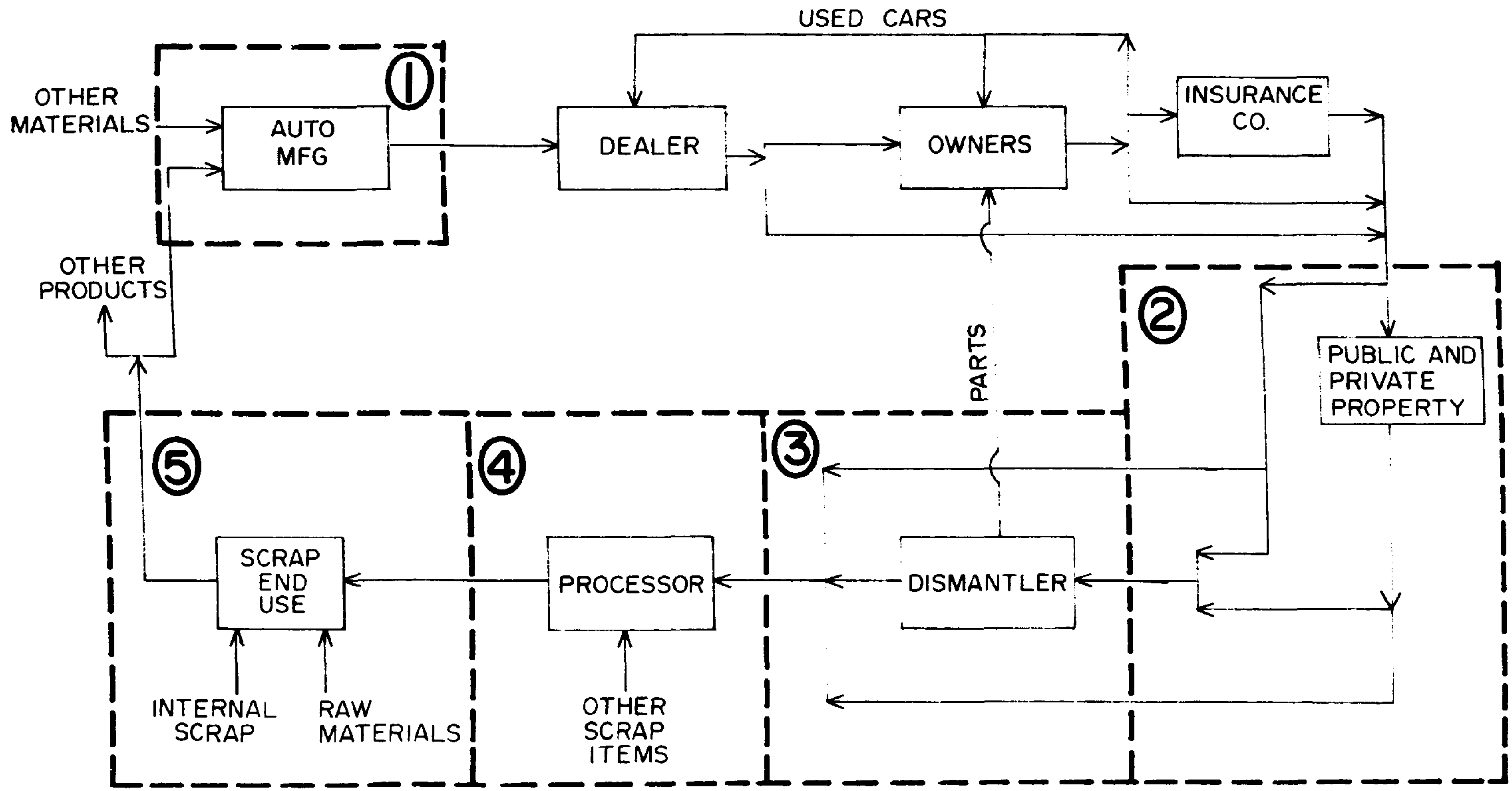

Figure 2. Key areas in the automobile scrap cycle.

as rural areas that promiscuous abandonment and large automobile graveyards litter our public property and occupy our open land. In addition to environmental pollution, these accumulated cars represent an unused resource.

Area 3 encompasses the dismantling industry and its attendant problems of automobile inventories, which cause aesthetic and resource conservation problems. In addition, many new and restrictive laws on air pollution, etc., can seriously affect and perhaps hinder this industry's valuable functions.

Area 4 represents the scrap-processing industry, an indispensable link in the final reuse of discarded automobiles. Yet this industry's methods of operation and inventories can also create environmental and resource conservation problems.

Finally, area 5 represents the industries responsible for the actual use of the scrap from processed automobiles. The trends in these industries will ultimately determine whether out-of-service automobiles will be reused and to what extent our natural resources will be conserved. Indirectly, their failure to use automobile scrap will increase the accumulation of automobiles abandoned and in inventory. This will further degrade our environment.

These five major areas are each discussed in detail to document current conditions, important new trends, and key decision areas, which, if encouraged or changed, can lead to more efficient automobile recycling with subsequent improvement in environmental quality and increased conservation of natural resources.

MOTOR VEHICLE MANUFACTURERS

General Description

The production of automobiles in the United States is carried out mainly by four manufacturers located in 40 cities in 17 States; the production of trucks and buses is performed by 15 manufacturers located in 35 cities in 17 States. The United States imports approximately 17 brands of cars, trucks, and buses from more than 12 countries. The import total has been steadily on the increase (Figure 3), but the export total (Figure 4) has not been increasing as consistently, in part because export of trucks and buses has decreased.

The motor vehicle manufacturer is related to the scrap cycle in that he produces the vehicle that eventually is consumed as scrap. Hence, the amount and type of automobile scrap available in the future can be assessed by looking at automobile manufacturing. Total production of automobiles for 1969 was approximately 8 million with an additional 2 million trucks and buses, or about 10 million total motor vehicles.[1] The production of motor vehicles appears to be on the increase and should reach about 15 million by 1980 (Figure 5).[2] Production plus net imports, those motor vehicles actually added to those in use in the United States, are also shown (Figure 5).

The amount of steel used in cars is static or declining while the use of nonferrous materials, primarily used in the options that are now available, is increasing. This material consists principally of plastic (inside trim, tail lights, grill, etc.,); vinyl (roofs);

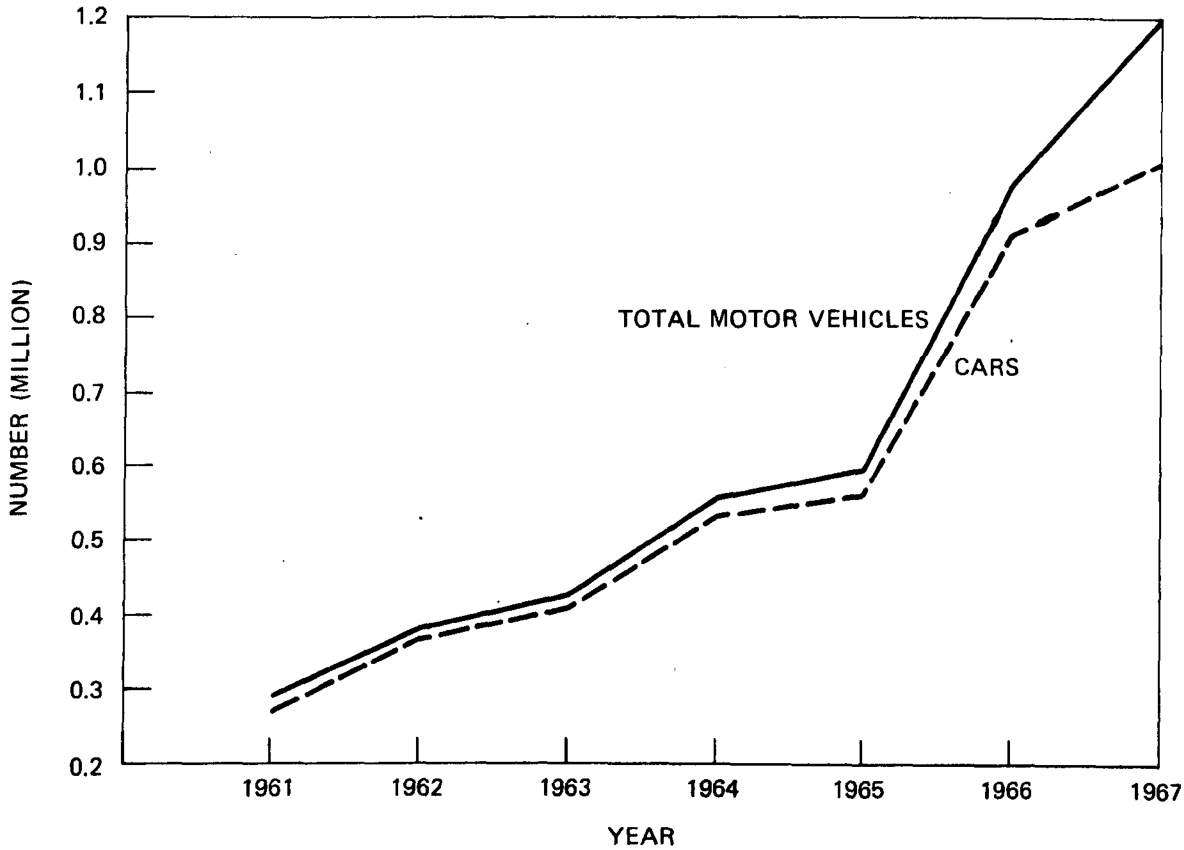

Figure 3. U.S. motor vehicle imports.

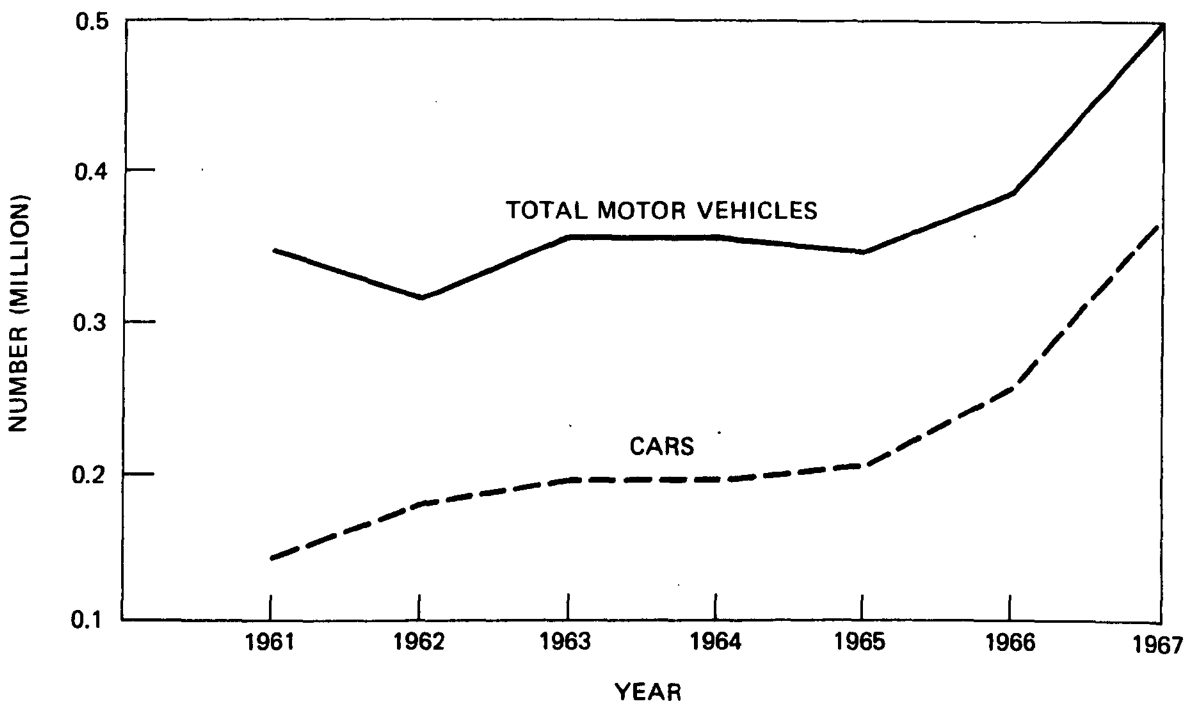

Figure 4. U.S. motor vehicle exports.

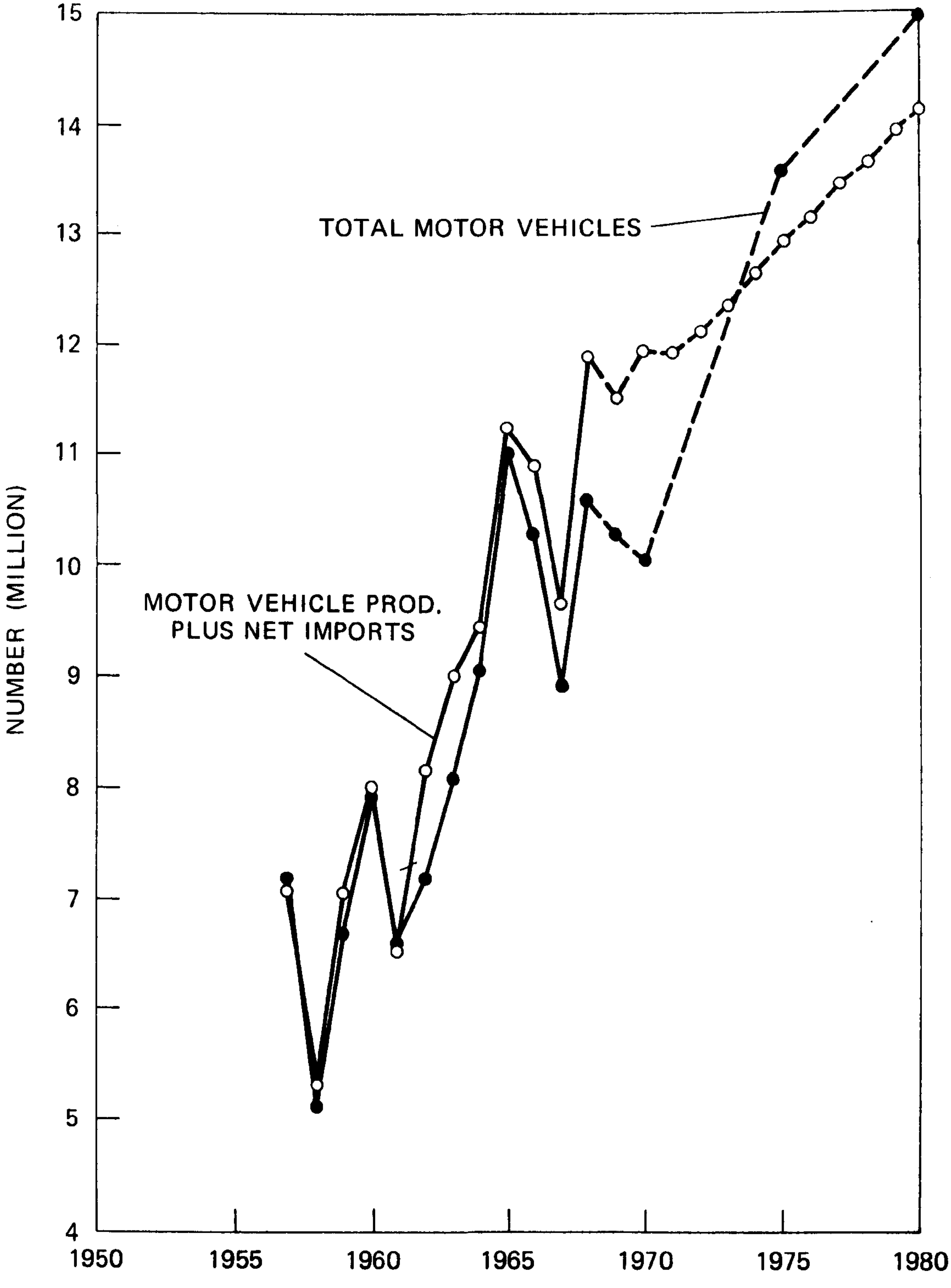

Figure 5. U.S. motor vehicle production.[6,11]

rubber-like material (bumper); copper for power windows and seat motors (although overall copper might decrease owing to better engineered alternators and printed circuits in ignition systems); and nonferrous metals (wind stabilizers, spoilers, etc.). It was estimated, for example, that 1 billion lb of plastic materials would be consumed by motor vehicle manufacturers in 1970.[3] Consumption of rubber products was estimated at 210 lb per car for 1970.[4]

Resource Conservation

Since the scrap cycle starts with the production of the motor vehicle this is a good place to consider ways to improve the dismantling of the vehicle. In order to determine if improvements are necessary or even feasible, it is necessary to look at the composition of the motor vehicle. Some studies on the composition of the automobile have been completed,[7-9] but no known work has been undertaken on trucks and buses. The lack of composition data on trucks and buses is not critical, because there are substantially more automobiles than trucks and buses and because the same general procedures and problems involved in scrapping trucks and buses are also encountered in scrapping automobiles.

The composition of the various makes and models of automobiles varies to some extent. The Bureau of Mines has compiled composition data on a "typical" automobile.[7] This composite was derived from data obtained when 15 automobiles were dismantled and analyzed (Table 1). It can be considered to be a 10-year-old, four-door sedan, in the low-price class, with automatic transmission and heater, and of modified unitized body design.

TABLE 1

TYPICAL AUTOMOBILE COMPOSITION[7]

Material	Lb	Total automobile (%)
Light steel	1,309.5	36.6
Heavy steel	1,222.4	34.2
No.2 bundle steel	2,531.9	70.8
Cast iron	511.4	14.3
Copper*	31.9	0.9
Zinc†	54.2	1.5
Aluminum‡	50.6	1.4
Lead	20.4	0.6
Rubber	145.0	4.1
Glass	87.2	2.4
Other combustibles**	127.2	3.6
Other noncombustibles††	14.8	0.4
Total	3,574.6	100.0

*Including copper in brass but not copper in solid solution in steel.
†As zinc base die cast exclusive.
‡As scrap sheet and cast aluminum.
**Cardboard, textiles, padding, plastics petroleum products, etc.
††Dirt, glass wool insulation, body putty, and ceramics.

The Bureau of Mines estimated that the scrap value of all the metallic components of the car would have been about $55.94. Five metals of various weights and values could be recovered (Table 2). A dismantling/processing yard was hypothesized to process the car. The cost to separate the components was estimated to be $51.25. Hence, a profit of about $4.69 per car could be realized.

Although such an operation is feasible, there are few if any processing yards in the country that can operate on the scale of the hypothetical dismantling/processing yard. This yard is more the exception than

TABLE 2

VALUE OF RECOVERABLE METALS IN COMPOSITE AUTOMOBILE[5]

Metal	Lb	Price	Value
No. 2 bundle iron	2,614.0	$18.70 per ton	$24.44
Cast iron	429.3	42.20 per ton	9.06
Copper:			
Radiator stock	15.4	0.3275 per lb	5.04
No. 2 heavy and wire	13.8	0.396 per lb	5.46
Yellow brass solids	2.7	0.31 per lb	0.84
Zinc, die castings	54.2	0.0625 per lb	3.39
Aluminum, cast, etc.	50.6	0.124 per lb	6.27
Lead:			
Battery	20.0	1.40 per battery	1.40
Battery cable clamps	0.4	0.11 per lb	0.04
Totals	3,200.4		55.94

the rule. Most dismantlers and processors are separate operations and must dismantle on a small scale. Hence, it would be impossible for the typical dismantler to strip a car to the degree necessary to realize the expected value for the estimated cost of $51.25.

The typical dismantler removes the components that are easily marketed, usually the radiator, battery, motor and related parts, and sometimes the radio, and then tries to sell the remaining hulk. The problem arises in the fact that the remainder still contains unwanted contaminants, including copper, which make the hulk unappealing as a source of steel scrap. The maximum desired level of copper in scrap is about 0.15 percent by weight.[10] Since the car contains about 0.07 percent copper in solid solution in the steel, this means that only 0.08 percent copper is permitted to be left on the hulk. Data obtained from the Bureau of Mines' typical automobile indicates that the normally removed parts (radiator, battery, motor, and related parts) account for only 21.0 lb of the 31.9 total lb copper in the vehicle. Removal of other common parts like the transmission, differential, brake drums, and brake cylinders still leaves 9.6 lb of the remaining 10.9 lb copper. This remainder is still in excess of the .08 percent permissible. This copper can be separated, but this is difficult and quite time consuming. The value of these materials as parts is negligible, and their scrap value is low. The only reason for removal, therefore, is to make a high-quality No. 2 bundle. Since it is impossible to tell if the copper has been removed, it is easier to leave it in, and this apparently has been occurring over the past few years. Therefore, a steel manufacturer usually pays only for a low-quality No. 2 bundle or may not even want the scrap at all.

Key Decision Areas

Since an automobile is designed for transportation, not scrappage, little consideration is given to the eventual problems in its recycling. Some work has been done, however, to determine how the scrapping potential might be improved during construction.[8,10] These methods are primarily directed to reducing the copper contamination level of vehicles so that high-quality steel scrap can be obtained. Although the thought was to decrease the copper contamination in the No. 2 bundle, the design changes suggested could also improve other types of automobile scrap (i.e., automobile slab and automobile shreddings).

The easiest way to remove copper from a car is not to have it there in the first place. Poliskin suggests that the copper wire in the automobile be replaced with aluminum.[10] The conductivity of aluminum is about 62 percent that of copper, but since aluminum has a lower specific gravity, 1/2 lb of aluminum could replace about 1 lb of copper as an electric conductor. The diameter of an aluminum conductor would be approximately 50 percent greater than the equivalent copper conductor. The property of aluminum that makes it suitable as a substitute for copper is that during melting and refining of scrap steel, the aluminum oxidizes and enters the slag and therefore separates from the steel while copper dissolves into the steel. Further reduction in copper can be obtained by replacing the electric motor stators, presently wound with copper, with stators composed of permanent ceramic magnets of barium or strontium ferrites.

The typical car has 5.6 lb of copper electrical wire and electric motor wire that could be replaced with aluminum. If the heater core is also removed (a quick job) total copper content would be approximately 0.16 percent in the steel scrap. This is very close to desirable levels in steel manufacture.

Another way to provide scrap with less copper contamination is to provide an easy method of removing the parts that contain copper. Stone has proposed several of these mechanisms.[8] If copper components now present under the hood were placed in one or two standard locations, removal would be simplified. One location might be a mounting bracket on the radiator (which is usually removed anyway). This bracket might contain the horn, voltage regulator, relays for high-current-draw accessories, and the solenoid (if not located on the starter). Other copper-containing components (heater core, windshield wiper motor, heater motor, and some relays) might be attached to a plate located on the fire wall. All wires going to and coming from these two locations could be consolidated in one or two wire looms, that would be easily removed during dismantling.

Removal of the plate on the firewall could provide easy entrance to the wires and instruments under the dashboard. If the dashboard wires were consolidated into a wire loom and had pullaway connecting plugs, these could be easily removed. A standardized location for the fuse box that would serve as a junction for the wiring would also assist in wire removal. If instruments were mounted in groups around the driver, as is the present trend, this entrance would also provide easy access for removing them.

The body wiring could be consolidated wherever possible and enclosed by a plastic conduit mounted beneath the car. If the connections of these wires were of the pullaway type, removal would be simplified.

Motors for such accessories as power seats and power windows could be positioned for easy removal. The motor for the power seat could be attached to the seat, which is normally removed. The motor for power windows could be in the armrests, which are quite easy to remove.

Numerous design changes are possible, and many appear quite feasible. Some changes, such as making power window motors more accessible, could even lower repair costs. Others, such as locating high-currentdrain relays close to the battery might lower production costs. Assuming that the suggested design changes are made and that the voltage regulator, electric motors, heater core, dashboard wiring, instruments, radio, body wiring, horn, and relays are removed, about 1 lb of copper would remain in the car. This is about 0.04 percent of copper by weight of the steel scrap. The total copper remaining in the hulk would be 0.11 percent, well within the 0.15 percent desired maximum.

ABANDONMENT

General Description

When a motor vehicle is no longer considered of value by its owner, he can dispose of it in an acceptable manner or abandon it on public or private property. Since abandonment has adverse effects on the environment and on resource conservation, it is a key part of the motor vehicle scrap cycle.

Each year a growing number of motor vehicles have been retired from service (Table 3). Estimates for future years project continuing growth of out-of-service vehicles (Table 4).

For example, it has been estimated that of the more than 100 million vehicles on the road in 1970, 8 to 9 million would go out of service.[14] The key question is how many would be abandoned? In New York City, for example, 20 times more abandoned automobiles are removed annually than were removed 10 years ago (Table 5). Estimates for abandoned vehicles nationwide are shown (Table 6). The accumulation of abandoned vehicles on public and private property will probably increase if no

TABLE 3

ESTIMATED NUMBER OF VEHICLES RETIRED FROM SERVICE
(in millions)

Year	Federal Estimate[11]			Trade Association Estimate[12]	R. L. Polk & Co.[13]		
	Cars	Trucks & buses	Total	Cars	Cars	Trucks & buses	Total
1965	6.0	0.9	6.9	6.0	6.2	1.1	7.3
1966	6.4	0.9	7.3	6.3	7.0	0.9	7.9
1967	6.0	1.0	7.0	6.6	6.2	0.9	7.1
1968	6.6	1.1	7.7	6.9	6.3	1.0	7.3

TABLE 4

ESTIMATED NUMBER OF VEHICLES RETIRED FROM SERVICE*[11]
(in millions)

	1969	1970	1971	1972	1973	1974	1975	1980	1985	1990
Cars	6.8	7.5	7.6	7.8	8.0	8.2	8.6	9.6	10.8	12.0
Trucks & buses	1.1	1.4	1.5	1.6	1.7	1.8	1.8	2.0	2.4	2.6
Total	7.9	8.9	9.1	9.4	9.7	10.0	10.4	11.6	13.2	14.6

*The motor vehicle registrations used in this forecast are based primarily on experience, plus population data. The production and retirement (scrappage) forecasts are computed on the basis of the numbers necessary to maintain the forecasted motor vehicle registrations, provided that the average vehicle life is 10 years. If safety, emission controls, or other factors change the average vehicle lifespan or if the registration forecast proves wrong, the retirement forecast would have to be changed accordingly.

TABLE 5

NEW YORK CITY-ABANDONED CARS REMOVED

Year	1959	1964	1968	1969
Number	2,500	13,000	32,000	58,000

TABLE 6

ABANDONED-VEHICLE FLOW

Year	Optimistic*	Medium†	Pessimistic‡
1970	890,000	1,340,000	1,780,000
1975	1,040,000	1,560,000	2,080,000
1980	1,160,000	1,740,000	2,320,000

*Based on Department of Commerce estimate of 10 percent abandoned[15] and DOT estimate of out-of-service vehicles.[11]
†A 15 percent abandonment rate (note: actual rate for 1965 is estimated at 13.5 percent).
‡A 20 percent abandonment rate.

TABLE 7

ABANDONED-VEHICLE INVENTORY, PUBLIC AND PRIVATE PROPERTY

Year	Super Optimistic*	Optimistic†	Medium‡	Pessimistic**
1965	1,890,000	1,890,000	1,890,000	3,200,000
1970	900,000	1,890,000	3,636,000	5,916,000
1975	500,000	2,862,000	5,823,000	9,318,000
1980	500,000	3,972,000	8,321,000	13,203,000

*Estimates based on assumption that high scrap prices and demand will continue through 1980 and only residuals will not be put into the cycle.
†Using adjusted BDSA inventory[9] estimate in 1965, accumulation rate of 2 percent after 1970, DOT estimate of out-of-service vehicles.[11]
‡BDSA starting inventory, 4.5 percent accumulation rate after 1965, DOT estimate of out-of-service vehicles.[11]
**ISIS starting inventory,[12] 7 percent accumulation rate.

concerted action is taken (Table 7), but to date actions at the local and State levels are largely ineffective and expensive.

The owners of motor vehicles, those who determine how they will be discarded, are individual consumers, dealers, and insurance companies. There are four disposal alternatives for unwanted vehicles available to their owners; (1) dismantlers; (2) processors; (3) solid waste disposal sites; (4) public or private property. The first three are acceptable while the last involves abandonment.

To understand abandonment, the decisions that give rise to the problem must first be examined (Figure 6). Once the owner has decided that his vehicle is no longer of value to him (Decision 1), he then selects the way he wants to discard it (Decision 2). He may choose to dispose of it in a responsible and legal manner or to abandon it.

Roughly 10 to 20 percent of the motor vehicles retired from service each year are abandoned. The decision as to where to leave the vehicle (Decision 3) resulted in approximately 60 percent of the vehicles being abandoned on public land and the remainder on private property.[15]

The selection (Decision 4) of an acceptable (legal) way to dispose of the unwanted vehicle is partly based on a knowledge of disposal availability, convenience, costs of disposal, and local regulations. These items vary considerably in different locations and over time.

The decision to dispose of the vehicle at the processor or at the dismantler (Decision 5 or 6) may be rejected by the business (e.g., lack of demand or complex procedures for transfer of title) or by the owner (e.g., lack of "value"). At the solid waste disposal site, the

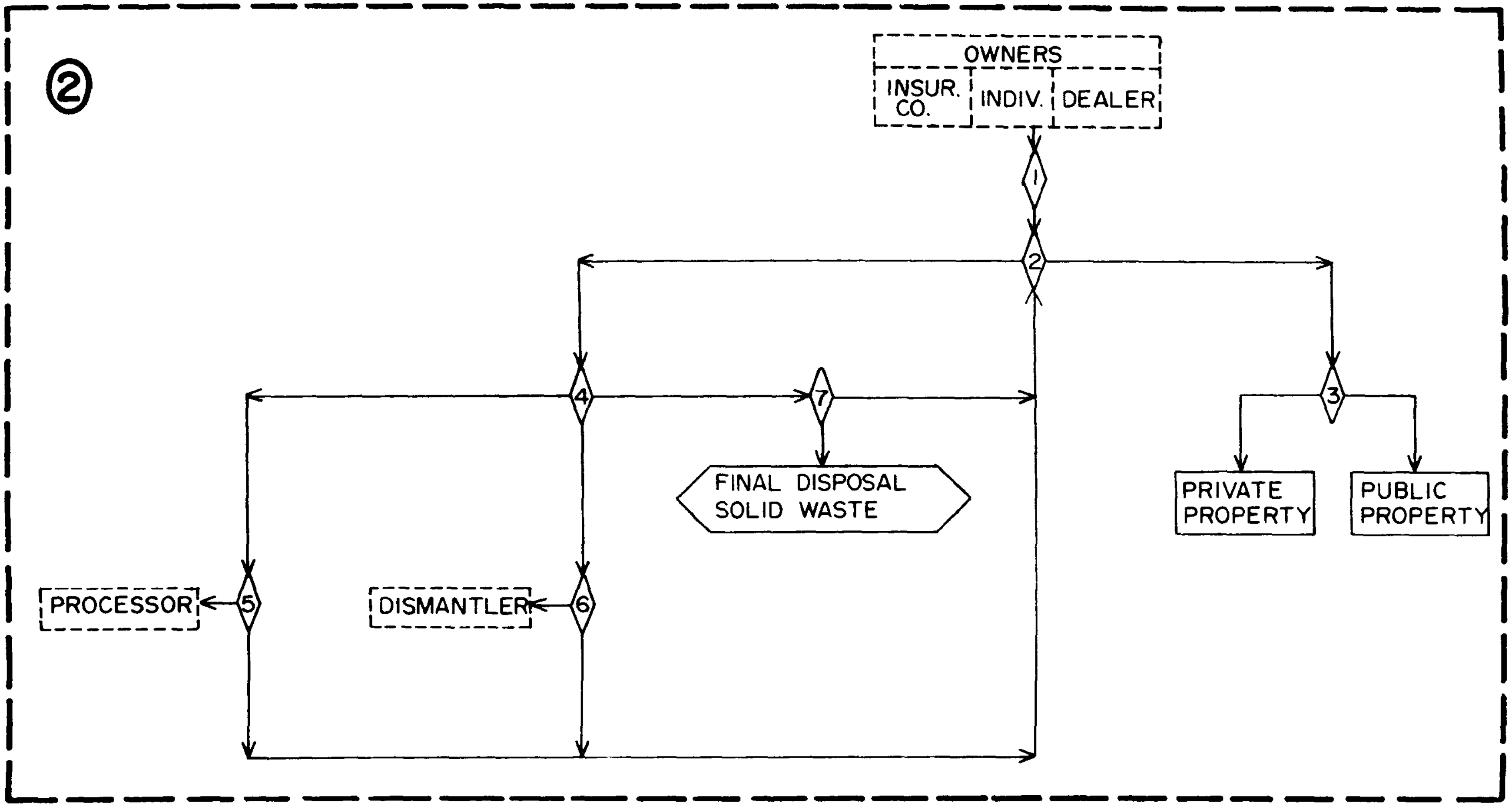

Figure 6. Abandonment: problem creation.

vehicle may be rejected (Decision 7) by the operator as not being acceptable at the site, or the fee charged may be too high. In these three cases, the decision on how to dispose of the vehicle is again made by the owner (Decision 2). Obviously, rejection at acceptable sites increases the likelihood of abandonment, and the owner decides where to abandon it.

Given that there presently is an abandonment problem, the decisions that affect the flow of abandoned vehicles from public and private property to acceptable disposal places are examined next (Figure 7).

Vehicles stored on their owners' private property are not cases of abandonment, but they provide many of the same hazards and problems as if they were. Local laws (e.g., zoning, licensing) may regulate storage of these vehicles. If the owner decides (Decision 1) to dispose of a stored vehicle, the process is the same as if the car were abandoned on his property by someone else. If the local government decides (Decision 2) to remove the vehicle (a complex question of jurisdiction over private property arises), the situation is similar to that in which the car has been abandoned on another's property.

The decision to remove an abandoned vehicle from private property may be made by the individual who owns the property (Decision 3), or by the local government (Decision 4), if empowered to do so. If it is made by the individual, he must decide how to remove the vehicle (Decision 5). He may ask the help of the local government or of a private tower or do it himself. The private tower may not agree to do it (Decision 6), or the government may have a contract agreement

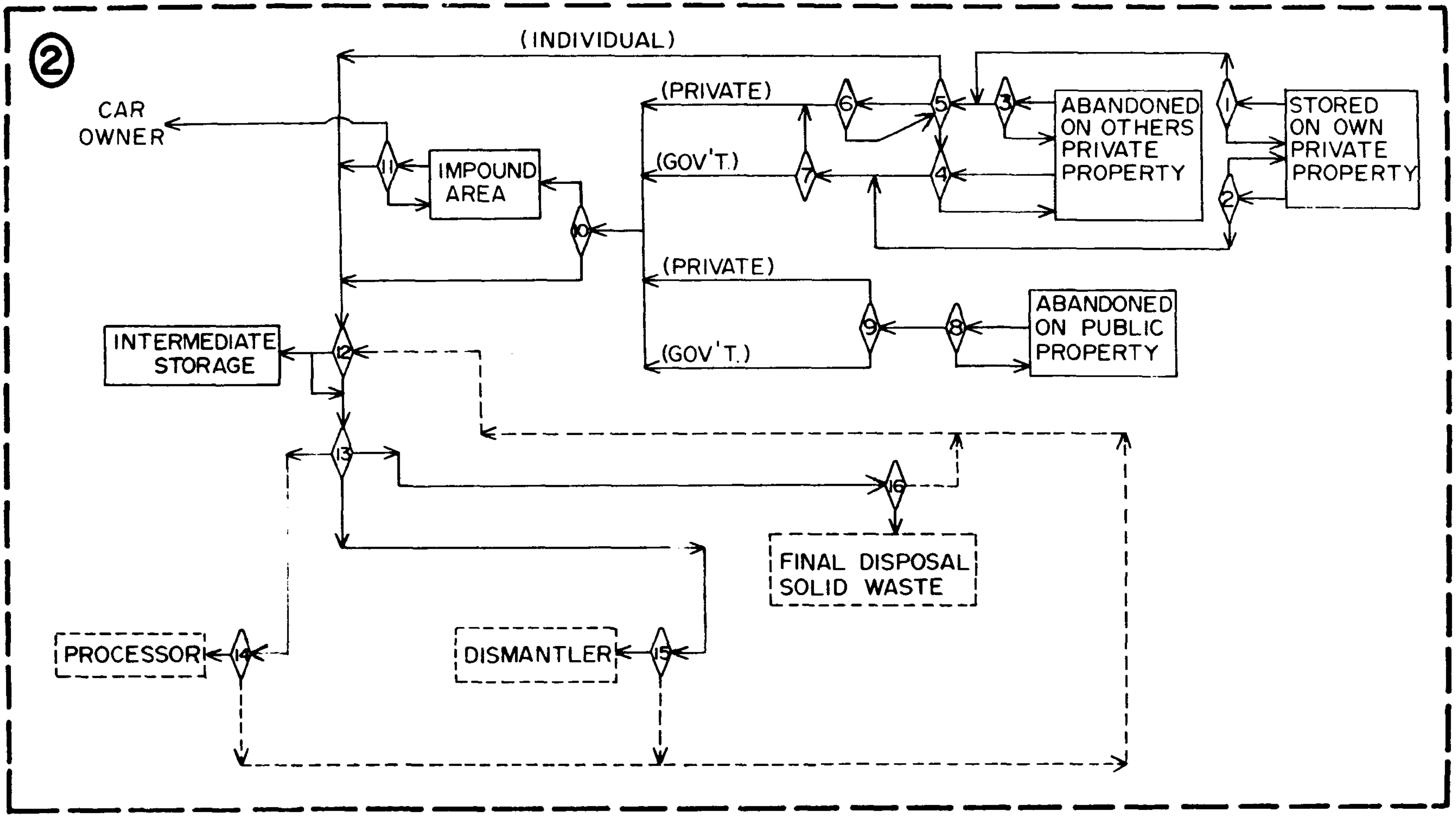

Figure 7. Abandonment: problem solution.

(Decision 7) with private towers for the removal of vehicles in specified districts.

The local government makes the decision on whether to remove a vehicle abandoned on public property (Decision 8). It will either remove it or contact a private tower with whom it has a contract (Decision 9).

Once the vehicle is removed by the government or private tower, a decision is made on the necessity for impounding it (Decision 10). Release of the car from the impounding area is made after its owner does not reclaim it (Decision 11).

The next decision is whether to put the vehicle into intermediate storage or haul it immediately to a dismantler, processor, or disposal site (Decision 12). Anticipated increases in scrap prices or the practice of accumulating several hulks before hauling may encourage the intermediate storage of vehicles.

One of the three ways of disposal is selected: processor, dismantler, or a solid waste disposal site (Decision 13). The method chosen may be rejected at the site or deemed not worthwhile (Decisions 14, 15, and 16). If rejected by either party, the decisions of storage (Decision 12) or selection of an alternate place (Decision 13) come up again. The flow and inventories for out-of-service vehicles in 1965 are shown in Figure 8. (The flows represented by dashed lines in Figures 6 and 7 are discussed in detail later.)

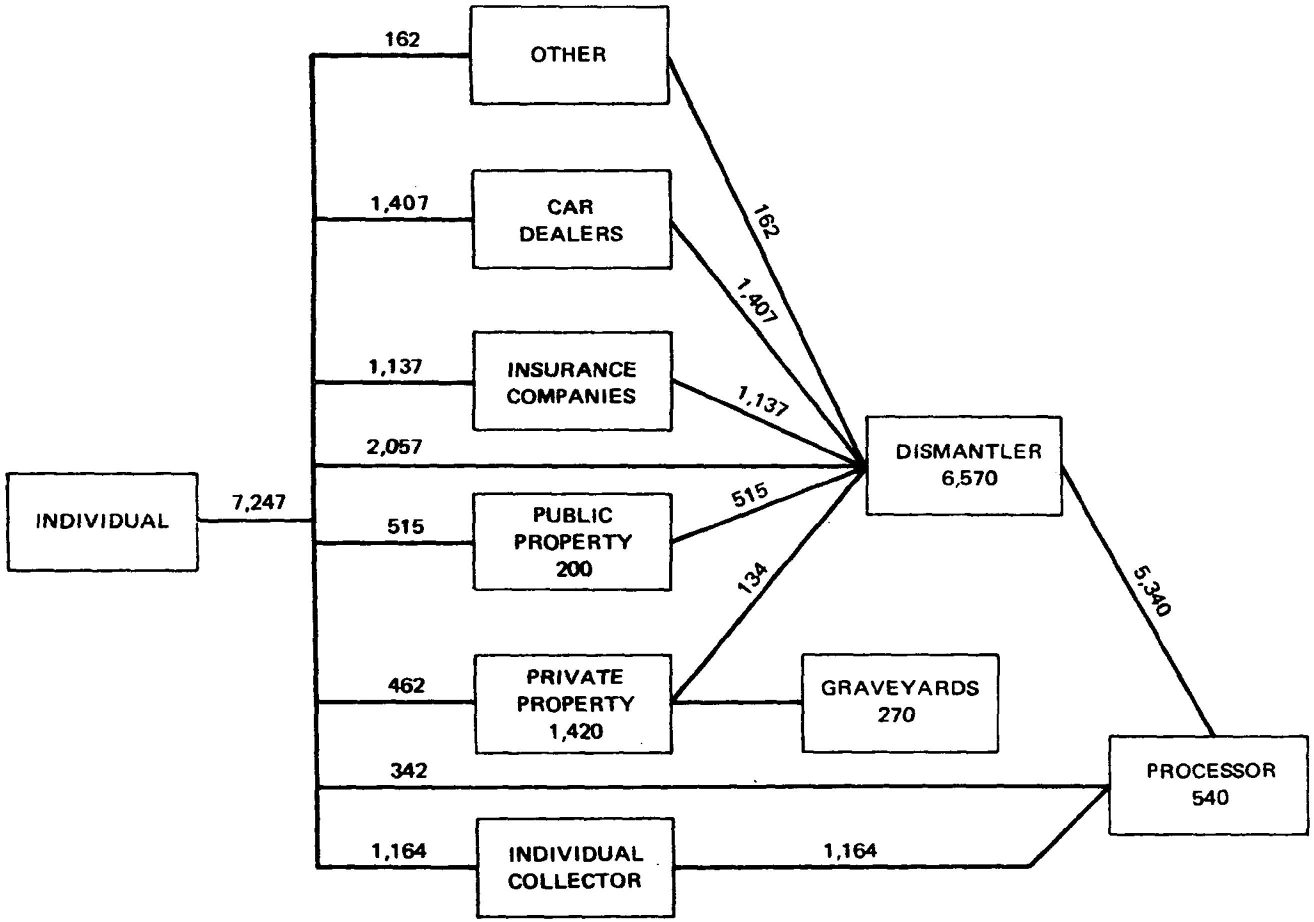

Figure 8. 1965 estimated flow and inventory of out-of-service motor vehicles (in 1,000's), based on reference 9 and OSWMP estimates. *Inventories for each cycle segment are inside the boxes.*

Environmental Damage

Environmental damage is centered in the areas of: (1) abandonment on the private property of others; (2) abandonment on public property; (3) storage on own private property; (4) intermediate storage; (5) impounding lots.

Automobile hulks are unsightly and generally reduce aesthetic values. Vehicles stored on private property or left abandoned extend and aggravate urban blight. At times, abandoned cars become traffic safety hazards and reduce the traffic flow capacity of streets. Children are attracted to the hulks in their neighborhood, using them as playgrounds, which are fire and safety hazards. As breeding places for rodents and insects, these hulks become health hazards as well.

Resource Conservation

Metal and other materials in discarded automobiles are valuable resources that are not being used if the vehicles remain abandoned. Preservation of natural beauty and open space cannot be maintained with abandoned vehicles in abundance.

Key Decision Areas

The key decision that creates the abandonment problem is Decision 2 in Figure 6, that is, whether to dispose of the vehicle in an acceptable manner or to abandon it on public or private property. Unfortunately, it is easier to abandon an automobile than it is to dispose of it properly. The cost of having a vehicle hauled away may be greater than the rarely enforced penalty for abandoning it. Private collectors, dismantlers, and scrap processors often will not accept certain vehicles (Decisions 5 and 6 in Figure 6). Even solid waste disposal sites (central incinerators, sanitary landfills) frequently turn down car hulks (Decision 7). Hence, not only must a responsible decision by the vehicle's owner be encouraged but also the vehicle must be accepted by dismantlers, processors, or others (Decisions 5, 6, and 7), or the owner may have no alternative but to abandon his vehicle. In order to maintain a well-functioning automobile scrap cycle, it is necessary for individuals to be able to dispose of their unwanted motor vehicles without excessive expense and without violating the law. It is essential that automobile owners be able to place their old cars into the cycle with greater ease than now exists.

The vehicle owner's original reason for abandonment is in many cases based on ignorance. The individual responses to a U.S. Department of Commerce study on abandonment for 1965 showed the following results:[15]

	Percent
1. The car broke down and I left it where it was	30
2. It cost too much to have the car removed	25
3. I did not know where to take the car or whom to call	25
4. I could not find the title or the bank had the title	10
5. Other reasons	10

If the cost (or penalty) of abandoning a car were greater than the expense for having it removed, or if an artificial value of sufficient size were placed on the vehicle, then 55 percent of the reasons for abandonment would be eliminated. If the public were made aware of where and how to dispose of their cars, an additional 25 percent of the abandonments would be prevented. Thus, 80 percent of the reasons for abandonment as reported in this study could be greatly reduced through positive action.

The reasons for rejection by dismantlers and processors are complex and are more fully dealt with in the discussions of their respective industries. The legal problems of the title transfer are a major factor affecting their decisions. Because of these barriers, an increasing number of vehicles are abandoned, and this transfers the disposal problems from individuals to the local government.

Barriers also exist that slow the removal of abandoned vehicles. Presently there is little or no financial incentive in most places for property owners to remove old cars from their property and have them actually delivered to a scrap processor or for an automobile owner to make sure that his junked car reenters the cycle.

Government's greatest problems are related to its authority to remove vehicles stored on private property. If the storage location is not operating as a business and is too small to be classified a graveyard, zoning and licensing do not apply. Protection of individual property rights often restricts the government's authority to take the vehicles (Decision 2 in Figure 7).

The cost of removal of vehicles by the government (Decisions 2, 4, and 8) is presently high and rapidly increasing. New York City's Department of Sanitation, for example, had to pay between $50 and $60 in labor and operating costs to remove each car before it contracted private towing firms, which now pay the city up to $5 for each car removed.

A long period of impounding time (Decision 11) is required to: (1) determine ownership; (2) search for lienholders; (3) give notification; (4) advertise; (5) hold for a specified time; (6) auction. Impounding lots usually operate at capacity, this often being the critical factor preventing the continued removal of abandoned vehicles from public and private property (Decisions 4 and 8).

The intermediate storage (Decision 12) areas (e.g., at gasoline stations) scattered throughout the city may look like junk yards, for example, since towers may wait for an increase in scrap prices or an accumulation of vehicles before hauling them away.

DISMANTLING INDUSTRY

General Description

The third major element of the automobile scrap cycle is the dismantling process for automobiles. The term "dismantling" is used herein synonymously with other common terms such as "wrecking," "junking," and "salvaging." The function actually performed by a company using any of these terms in its title is generally the same: (1) obtaining unwanted automobiles from automobile dealers, insurance companies, consumers or municipal pounds; (2) selling usable parts from these automobiles; (3) keeping an adequate inventory of parts through a substantial hulk accumulation; and (4) removing outdated hulks to processing facilities. The function performed by the dismantling industry is invaluable as a source of used automobile parts for repairs. Without the parts supplied by this industry, automobile repairs would become impossible on many older model vehicles.

The need for the services of the dismantling industry has spawned its growth in every corner of the country. In 1968 an estimated 15,600 companies were engaged in dismantling operations employing 98,500 workers.[16] The industry is characterized by a large number of small companies, 17 percent of which are one-man operations and 53 percent of which employ from two to five employees.[16] This is not to imply, however, that the economic impact of the industry is small. In 1968 the industry had gross receipts totaling more than $4.7 billion, which, on the basis of 9 million automobiles and trucks handled, amounted to $523 per vehicle. This contrasted with an average price paid for incoming vehicles of $280 per automobile and an average $7 per automobile return for the sale of the hulk, which left an average of $250 per automobile to cover operating expenses and profit.[16]

The role of the automobile dismantler in the scrap cycle is significant because it provides a link between the community and the scrap processors. In 1968 the dismantlers not only handled the estimated 7.7 million vehicles that were taken out of service but also eliminated 1.3 million of the backlog of vehicles previously abandoned.[17]

Method of Operation

Within the industry, many different techniques are used in handling vehicles. Since variations in standard operating procedures can affect the aesthetics and the economics of a company, it is important to analyze the procedures commonly found within the industry. Reference to a schematic diagram of the industry will complement the discussion (Figure 9).

The first problem facing the dismantler is locating a source of vehicles. Vehicles for dismantling come from several sources (Table 8): (1) private individuals; (2) automobile dealers; (3) insurance companies; and (4) State and local agencies through vehicle impoundment.

By far, the large majority of dealers prefer late-model vehicles because of the increased market for the parts. Dealers retain the right to reject vehicles even if they are brought to them (Decision 1). This is especially true of early-model vehicles with any damage whatsoever to the body. In addition, the widespread practice of private individuals stripping parts from abandoned cars severely weakens the market for older vehicles. Owners of these vehicles cannot dispose of them through normal channels and therefore abandon them in despair.

Once a vehicle has been acquired by a dismantler, he must decide the best way to handle it (Decision 2). This procedure is generally established from the beginning of the dismantler's operation and is altered only because of restrictions subsequently placed on the operation. There are generally three choices available: (1) dismantle the vehicle and store or sell the parts (a technique used by only the high-profit

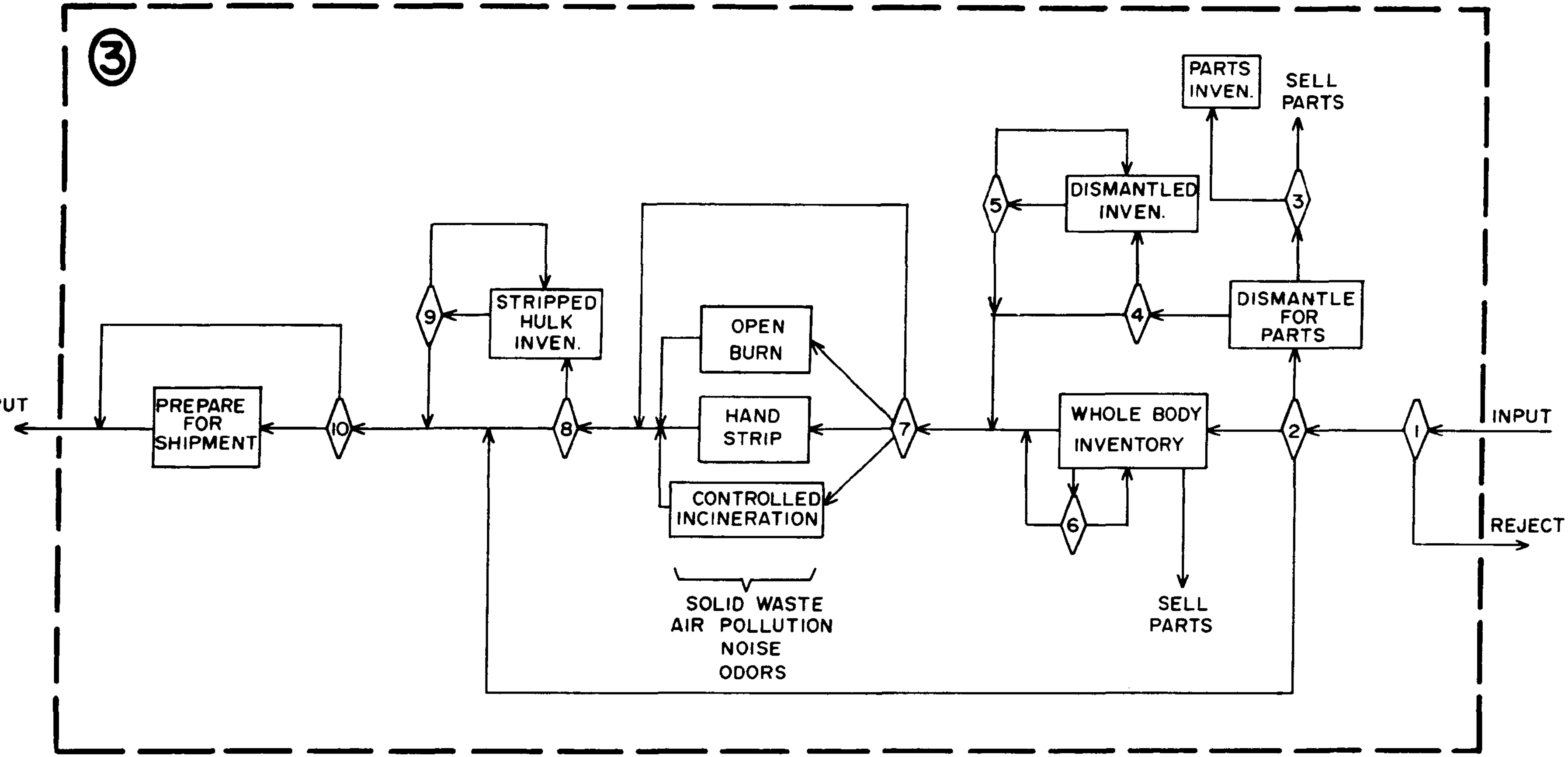

Figure 9. Automobile dismantling industry.

TABLE 8

AUTOMOBILE-WRECKING INDUSTRY'S INVENTORY SOURCES,[9] 1965

Sources		Percent
Individuals		38
Automobile and truck dealers, new and used		26
Insurance companies		21
State and local agencies		12
Other		3
	Total	100

urban dismantlers); (2) store the vehicle undismantled with parts to be removed later as needed; (3) shortcut the dismantling process altogether and make little or no attempt to reclaim any parts. The outcome of the decision concerning which of these alternatives will be chosen is determined by the location of the dismantler, the quality of the vehicle, the age of the vehicle, the proximity of a processor, the size of the dismantler's inventory, and the basic method of operation of the dismantler. The second method is generally chosen because it requires less labor and because in most cases storage space is not a problem. If, however, the dismantler chooses to dismantle the parts, he must also decide whether or not to store dismantled vehicle hulks (Decision 4) and whether to store dismantled parts or to sell them directly (Decision 3). In any case, if the hulks are inventoried, a decision must eventually come to remove them from inventory and return them to the cycle (Decision 5 or 6).

Once the parts have been removed, a decision must be made to determine how the waste material will be removed from the dismantled hulk (Decision

7). In some cases, no waste removal is required by the processor, since his equipment can remove waste materials. If wastes are removed by the dismantler, there are generally three methods available: (1) open burning; (2) hand stripping; (3) controlled incineration. Traditionally, open burning has been the least expensive and most widely used of the three methods. In many areas, stricter air pollution standards are all but eliminating this alternative. Hand stripping is being more widely used in areas with open burning restrictions. It is very expensive, however, with a cost ranging from $3.00 to $5.00 per vehicle.[16] In some marginal operations, this alternative is economically impossible. Controlled incineration is slowly taking the place of open burning. The switch to this form of waste removal is slow, however, since it requires the installation of equipment to ensure control of air pollutants. A result of waste removal is the accumulation of waste materials in the dismantling yard, and in some cases, this accumulation can occupy a considerable amount of space.

After the waste materials have been removed, the hulks may be stored temporarily (Decision 8). This storage will generally not be for any appreciable period of time, but a decision to remove the hulk from storage must be made (Decision 9). When the vehicle is ready to be removed from the yard, sometimes a form of volume reduction is used before shipping to the processor (Decision 10). This is often some form of flattening prior to shipping via flatbed truck.

This constitutes the spectrum of activities performed by the dismantlers. Other variations of the techniques described have undoubtedly been used. The attempt here has been to examine the commonly found procedures.

Environmental Damage

Complaints directed at the dismantling industry from the general public usually stem from some form of environmental exploitation or deterioration caused by the industry. This is generally evidenced by various forms of pollution and aesthetic deterioration.

Air pollution is a major environmental problem for the dismantlers and could occur at Decision 7. Open burning, the primary source of this problem, is the cheapest and quickest way to remove nonmetallics from dismantled automobile hulks. In many areas, this practice is being outlawed by stricter air pollution control statutes. In rural areas, however, it may still remain one of the most common methods of waste removal.

Noise pollution is common to many operators. This is a difficult problem to rectify since machinery commonly used in the dismantling process is inherently noisy. Compacting, smashing, or flattening vehicles for removal to a processor as a result of Decision 10 also generates noise. Solution of the noise problem can be partially achieved through an information program that draws the attention of the dismantlers to the noise problem and suggests ways to minimize it.

A third environmental problem caused by the dismantlers is one of aesthetics. Many dismantlers' inventory practices resulting from Decision 2 create large piles of vehicle hulks that are aesthetically unpleasing. Attempts at screening legislation have partially corrected the problem near major interstate highways, but the coverup achieved by screening is not the best solution. Dismantlers' inventories have been estimated (Table 9).

Table 9

DISMANTLERS' CUMULATIVE INVENTORIES

Year	Optimistic*	Medium†	Pessimistic‡
1965	6,570,000	6,570,000	12,000,000
1970	3,285,000	6,958,000	12,388,000
1975	3,528,000	7,444,000	12,874,000
1980	3,805,000	7,999,000	13,429,000

*Based on inventory estimate in reference 9, reduced by 50 percent through 1970 to reflect removal of cars with little or no parts value, then 0.5 percent of out-of-service vehicles retained thereafter.
†Same inventory[9] but 1 percent retention rate.
‡Inventory based on references 9 and 12 with 1 percent retention rate.

Another environmental problem indirectly caused by actions of the dismantlers is the vehicle abandonment problem. By self-imposed vehicle input restrictions (Decision 1, Figure 9), the dismantler can adversely affect the number of vehicles abandoned. With some incentive, direct or indirect, to handle as many vehicles as possible, the abandonment problems caused by the dismantlers could be alleviated.

Resource Conservation

By holding large inventories of vehicles within their yards, dismantlers restrict the flow of vehicular scrap through the scrap cycle and thereby withhold the scrap from its reuse potential. This problem is influenced by the results of Decisions 2, 4, 5, 6, 8, and 9 (Figure 9), which determine the amount of scrap stockpiled and held in dismantlers' inventories.

Key Decision Areas

There are several key decisions within the dismantling industry that affect the expeditious flow of vehicular scrap (Figure 9).

Decision 1 determines whether or not a vehicle ever moves into the dismantling stage of the scrap cycle. The present reluctance of dismantlers to accept vehicles with a low potential for the resale of parts produces an adverse effect on the number of abandoned vehicles. Legal problems resulting from local statutes concerning abandoned vehicles cause dismantlers to be cautious about accepting titleless vehicles.

Decisions 2, 4, and 8 determine whether or not vehicles will be inventoried in the dismantling yard for any period of time. The present tendency of dismantlers to establish an inventory of vehicles for the potential sale of attached parts produces a delay in the movement of scrap through the scrap cycle.

Decision 7 determines the method by which waste materials are removed from a dismantled hulk. This decision is being increasingly influenced by the establishment of stricter air pollution regulations outlawing open burning. These regulations present an economic barrier to the small dismantling companies, which cannot afford to handstrip nonferrous waste materials from hulks. These companies may be forced to stockpile dismantled hulks because processors will reject them, and they may eventually be forced out of business, leaving their inventory of hulks behind. Small communities would be affected because abandoned vehicles would accumulate in the areas normally served by the extinct dismantlers.

A final barrier to scrap movement is the high freight schedule for automobile hulk shipment. This tends to restrict the movement of vehicular scrap from dismantlers to processors. Dismantlers tend to stockpile hulks waiting for higher scrap prices to cover the high freight costs.

PROCESSING INDUSTRY

General Description

Processors used balers, shredders, and shears to produce the estimated 8.6 million tons of motor vehicle scrap purchased by the iron and steel industry in 1967.[16] Most processed scrap was baled or shredded. Sheared automotive scrap is a relatively recent development. There are about 800 balers in operation in the country, some companies having more than one baler.[16]

The Business and Defense Service Administration (BDSA) has estimated that there are 62 shredder plants with an annual capacity of 4,163,000 tons of scrap production. In addition, seven more such plants were under construction or planned for 1970.[16] Their geographic distribution is shown (Table 10). Baler capacity is estimated to be at least that of shredders.

TABLE 10

GEOGRAPHIC DISTRIBUTION OF AUTOMOBILE SCRAP SHREDDER PLANTS IN THE UNITED STATES (STATUS AS OF DECEMBER 1969)[16]

	No. of plants*	Estimated annual capacity	
		Net tons	Percent of total
New England	4	205,000	5.0
Middle Atlantic	7	480,000	11.5
East North Central	19	1,470,000	35.4
West North Central	4	252,000	6.0
South Atlantic	7	265,000	6.3
East South Central	5	261,000	6.3
West South Central	6	198,000	4.7
Mountain	7	350,000	8.4
Pacific	10	682,000	16.4
Total	69	4,163,000	100.0

*Operating, under construction, or definitely planned for 1970. May include some plants also using other that automobile scrap. Source: BDSA estimates; based upon information from the Institute of Scrap Iron and Steel and automobile wrecking industry association data and shredder companies.

The actual physical operation of a processing facility begins with the receipt of the automobile hulk from the dismantler and ends with the development of a raw material that is useful for steel manufacturers (Figure 10).

After the dismantler has stripped from the vehicle all parts with significant market value, the remaining hulk is delivered to the processor. At this point, the processor must decide (Decision 1) what he is willing

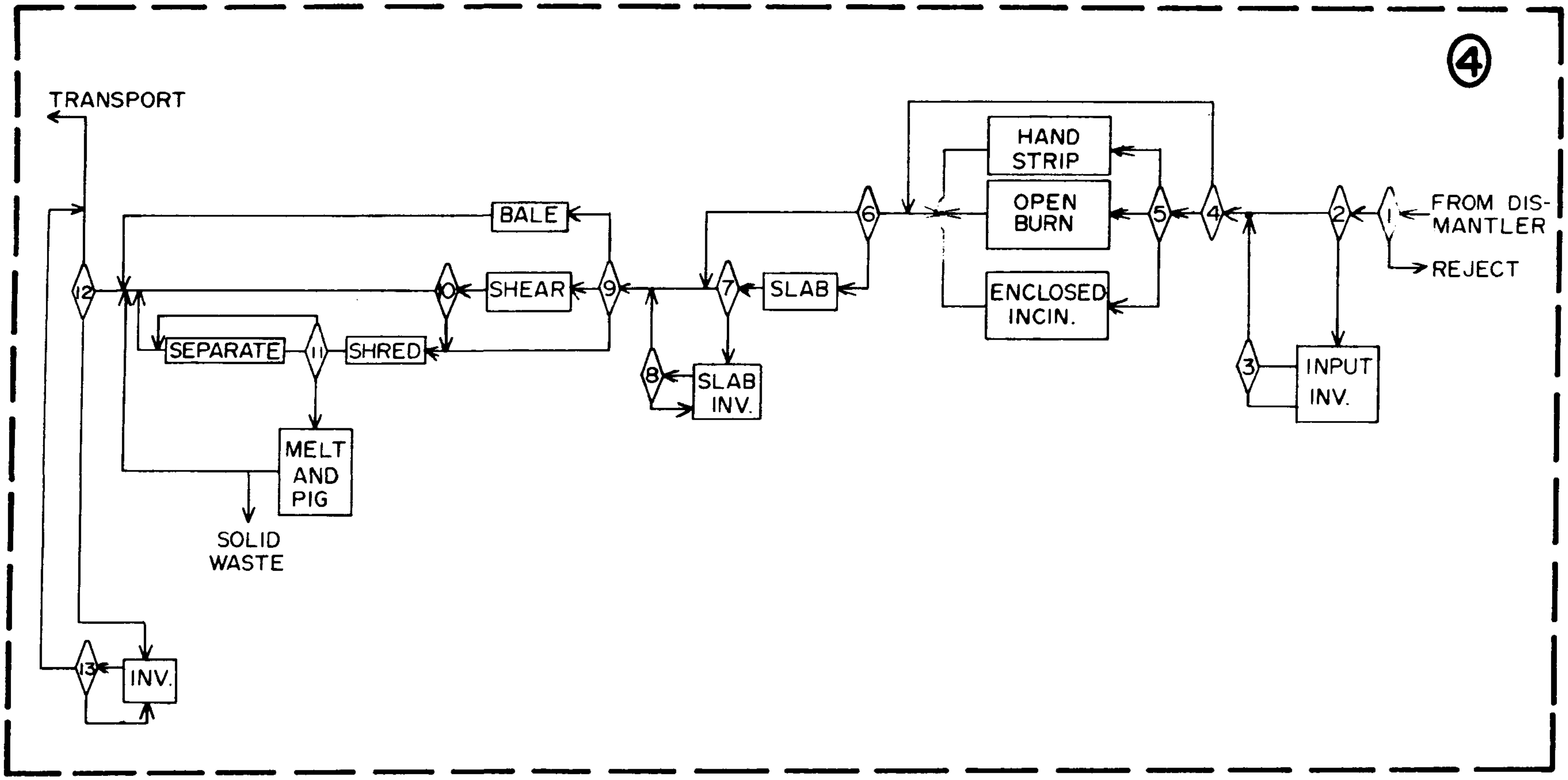

Figure 10. Automobile hulk processing industry.

to pay for the hulk. The hulk price depends on general acceptability, weight of recoverable material, expected scrap prices, and the amount of processing needed to separate the contaminants from the salable scrap. If the hulk is accepted by the processor, he has to decide (Decision 2) whether to process immediately or to inventory. Relevant factors that affect this decision are the operating capacity of the facility, the immediate market value of the scrap, and the mobility and amount of labor available to do the processing.

The next decision (3) confronting the processor is either to increase or decrease his inventory of unprocessed automobile hulks. The factors that influence his decision are the same as those outlined in Decision 2 as well as other factors, such as the marginal cost of land for storage.

Once the automobile hulk has been obtained either from inventory or directly from the dismantler to be processed, Decision 4 must be made whether or not it is desirable to strip the hulk further of contaminants. This decision depends upon the quality of the automobile hulk to be processed. If it is decided that the dismantler has removed enough of the contaminants (nonmetals and other material that have a marked effect on market value when mixed with ferrous metal) or if the actual processes to be employed can separate or reduce the contaminants to an acceptable level, further stripping can be bypassed. If, however, it is decided that there is a sufficient amount of contaminants that cannot be removed in the processes, further stripping cannot be avoided.

Having decided that further stripping of contaminants is needed, the processor must decide (Decision 5) which method best meets his needs. The choice between hand stripping, open burning, and enclosed burning is affected by many factors, the majority of which are beyond the control of the processor (i.e., prevailing air pollution laws, labor wage scale, beautification laws, etc.).

The next decision (6) to confront the processor is the choice of slabbing the automobile hulk. Slabbing is basically just compressing the hulk into a more manageable size--usually 2 ft X 2 ft X 20 ft. Slabbing is necessary if a guillotine shear is used in the processing scheme and is beneficial if inventory space is a problem or if transportation precludes further processing. The decision (7) to place the slabbed automobile hulks, "scrap logs," into inventory depends on the same factors affecting inventory Decision 2 on the prevailing market value of scrap and the production capability of the processes. The size of the inventory (Decision 8) also depends on the marginal costs of the land.

At this point in the processing scheme the most crucial decision (9) must be made. The processor has to decide the quality of the scrap his facility will produce and then specify the appropriate equipment and techniques to be used--baling, shearing, or shredding. This capital-intensive decision has a major effect on the unit costs of the whole scrapping process but also, and possibly more importantly, affects the unit revenue from the scrap.

If the automobile hulk is baled, processing ceases, and all that remains is to transport the bale to the steelmaker. If, however, shearing or shredding is considered, further decisions must be made by the processor. A shearing process using vibrating conveyors passing over magnetic separators produces a scrap of higher quality than baled scrap. Now the processor has the option (Decision 10) either to sell the scrap or to improve the quality further by shredding followed by magnetic separation. The main consideration is whether the increase of the unit costs by use of the shredder is less than the increase in revenue from a higher quality scrap.

Regardless of the decision to shear before shredding, another decision (11) has to be made by the processor after the automobile hulk has been shredded and passed over a magnetic separator. The scrap at this point is of better quality than baled scrap or sheared scrap. The scrap can, therefore, be easily marketed, but the processor may find that melting and pigging the scrap may upgrade its quality and increase its density, thus increasing the value of the scrap and reducing transport costs. Currently, however, this is not widely practiced.

After the scrap has been processed to a predetermined quality, the processor must decide (Decision 12) whether to place the scrap into inventory or ship directly to the steel-processing plant. The factors that affect this decision are the market price of the scrap, mode of transportation from facility to steel plant, and processing capabilities. Reducing inventory (Decision 13) depends on essentially the same factors mentioned in the previous inventory decision, the value of the scrap, marginal costs of the land, storage capacity and processing capabilities of the facility, mode of transportation, and aesthetics.

Environmental Damage

The scrap-processing industry affects the environment in two main ways: aesthetically by the inventory of automobile hulks, and by any action on the part of the industry that would place unreasonable constraints on the dismantling industry. This can cause increasing hulk inventories and also increased abandonment. Noise and dust may also be problems.

Resource Conservation

The scrap-processing industry is the critical link between useless automobiles and useful, ferrous scrap. Actions by the processors that affect either scrap price or quality adversely act as an impediment to reuse of automobile scrap in foundries and mills. This, of course, directly influences the increased use of raw ores and, hence, the decreased conservation of natural resources.

Key Decision Areas

The key decision areas in the automobile processing industry are inventory Decisions 1, 2, 3, 7, 8, 12, and 13, and process

Decision 9. Each area will be discussed in detail. The inventory decisions are affected by the following factors.

1. Fluctuations in the market value of scrap may cause the processors to inventory rather than process when the price is low.

2. The minimum operating capacity of the facility also affects inventory decisions and Decision 2 in particular. Even when the scrap prices are low, a facility continues to produce these inventories because of their fixed costs. This inventory also acts as a buffer to ensure that a minimum daily input to the processing equipment is maintained regardless of automobile hulk deliveries.

3. The cost of the land and taxes limits the inventory that a processor is willing to maintain. Currently, because most processors are in urban areas, this factor does limit input inventories significantly.

4. Aesthetics, new zoning laws, municipal ordinances, and the Federal beautification program have either regulated or have affected the costs of having large inventories.

The inventory Decisions at 2 and 3 involve automobile hulks; at Decisions 7 and 8, automobile hulk slabs; and at Decisions 12 and 13, either bales or sheared or shredded scrap. Automobile hulks are less pleasing to the eye than shredded scrap; similarly, more area would be required to store automobile hulks than to store shredded, baled, or sheared scrap. If, therefore, an inventory control were needed, it should be applied to automobile hulk inventory. This apparently is not a problem, however, because in 1965, processors processed more than 6 million vehicles. Of these, less than 10 percent were in inventory during the year.[9] Moreover, to prevent an inventory at the beginning of the process, the decision to reject the incoming automobile hulks (Decision 1) would be made. This would cause worse problems at dismantlers' yards and on public and private property.

Decision 9 in the processing scheme determines the quality of scrap to be produced, which in turn indicates the types of processes to be used. Basically there are three qualities of scrap produced by three different processes. The factors that affect the choice of quality and processes are the following:

1. The market value of the different qualities of scrap steel. As of February 1970, American Metal Markets Prices at Cincinnati, Ohio were No. 2 bundle steel (the product of a baler) $26.00 per ton; No. 2 heavy melting steel (the product of a shredder) $37.00 per ton.

2. The amount of available capital needed to purchase the selected process equipment. Given equal capacities, a shredding process requires a substantially higher investment than either a shear or a baler. A range of capital costs for each process is as follows:

Balers	\$ 15,000 to \$200,000
Shears	\$ 2,000 to \$175,000
Shredder	\$300,000 to \$3 million

3. As is evident by the price quotations, the shredder produces the highest quality scrap, and detailed demand analysis indicates that it has

higher demand elasticity. Therefore, the shredded product is much easier to sell, even in times of low steel production. Consequently, a more certain business may be possible.

The final transportation of the processed automobile scrap to the scrap users represents the final key problem area in the processing industry. The cost of scrap to manufacturers is a critical factor in their decision to use it, and this cost is a function of the raw-material cost (automobile hulks), the actual processing, and the cost of transportation.

As of 1966, the average cost per ton to haul ferrous scrap material was \$4.12 while the cost for iron ore was \$1.64.[18] These rates are in part based on relative percentages of usable raw material. As of 1966, usable raw ferrous material in ore represented approximately 60 percent of gross ore weight. On the basis of this adjustment, ferrous scrap should have been transported at a cost of \$2.46 per ton if iron ore were transported for \$1.64 per ton, minor increased costs of transporting scrap being assumed. The discrimination against scrap relative to iron ore amounted to \$1.66 per ton. Since 1966, several rate increases have caused costs of transporting scrap to increase to \$4.97 while iron ore transport costs rose to \$2.05 per ton. Adjusted to the 60 percent ore content, scrap should be transported for \$2.98. The discrimination amounted, therefore, to about \$2.00 per ton. In addition, pelletizing of iron ore has increased dramatically, and 90 percent usable content is expected in the near future. Even with the assumption of an increase of usable ferrous material to only 75 percent of total weight, the adjusted transportation difference between iron ore and ferrous scrap is $2.25. If the adjustment were ever to be 90 percent in reality, the difference would amount to almost $2.70.

Clearly, this differential added to the price of the scrap should be reevaluated in light of the environmental and resource conservation advantages associated with scrap reuse.

SCRAP-END USE

General Description

Any analysis of the possibilities of recycling automobile hulks to rid the landscape of these eyesores must necessarily involve a look at the iron and steel industry, for it is in this area that "recycling" actually occurs.

The steel industry and the foundry industry are the major consumers of scrap iron and steel. Production of raw steel has increased from 130 million tons[19] in 1965 to 139 million tons[20] in 1969. A 3 percent rate of growth in the consumption of steel mill products has been predicted to 1975.[21] Although production in the foundry industry has not changed from the 18.8 million tons produced in 1965,[9,22] a growth rate of 4.5 percent has been predicted to 1975.[22] Whereas the steel industry is concentrated in areas like Pittsburgh and Chicago, foundries are more numerous and widely distributed.

Definitions

The steel and iron industry normally uses properly prepared scrap in the production of castings. "Scrap" is a generic term that must be further defined to be meaningful in the following discussion. The areas of scrap origination used to define the scrap are listed in the order of desirability from the standpoint of the scrap user.

Home Scrap. In the production and casting of steel there is waste steel in the form of trimmings and spills at the steel plant. This home scrap is most desirable from the viewpoint of cost and the fact that it is of known composition and purity.

Prompt Industrial Scrap. This scrap is produced in industrial plants as they process and finish the raw steel for their own particular needs. It also is generally of known composition and purity.

Obsolete Scrap. This scrap is of two main types: (1) Demolition scrap. Although depreciated somewhat by age, this scrap is of fairly uniform quality and desirable to the steel industry; (2) Other. As the name implies, this type of scrap has various sources and thus is of varying quality and composition. One such source is processed automobile hulks. When the steel producer wishes to reduce consumption of scrap, "other, obsolete" scrap is the first to go.

Scrap iron and steel play an important and interchanging role in the production of raw steel and cast iron. The relative percentages of the various types of scrap used in iron and steel production are shown in Figure 11.

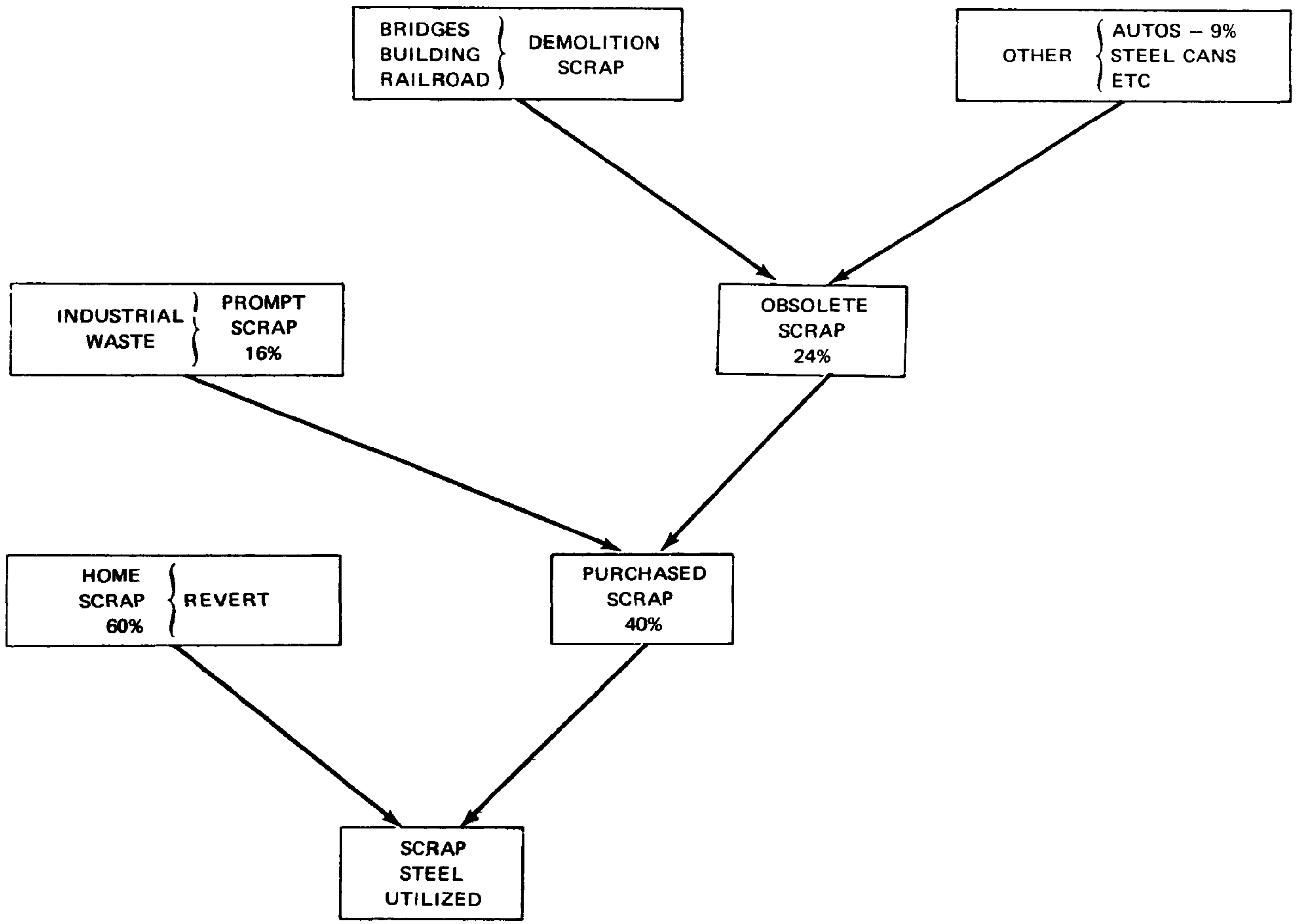

Figure 11. Scrap used in steelmaking.[8]

Steel Industry

The production of steel is illustrated in Figure 12. As steel scrap moves from the processor, it is exported, sold on the domestic market, or rejected (Decision 1). This decision generally depends on the selling price of scrap in each market and the quality of the scrap. The export of scrap steel has traditionally been significant. It is estimated that 9 million tons of scrap were exported in 1969, the majority to Japan. Because of the smaller capital investment in electric furnaces, developing countries are installing more of them. This trend may increase export demand for scrap steel, because electric furnaces can use over 90 percent scrap.

The exported scrap steel is from purchased scrap rather than from home scrap. This fact increases the impact that foreign markets may have on automobile scrap consumption.

At Decision 2, the ferrous scrap may either be used by steel plants or foundries (Figure 12). In 1969, 28.4 million tons of purchased scrap were used by the steel industry and 4.5 million tons by foundries. At Decision 3, steel scrap may be used in steel-producing furnaces or in blast furnaces in the production of pig iron. The reason for usage in pig iron production is unclear, but scrap consumption in these blast furnaces is considerable. In 1968, the consumption of scrap by this method was 4,267,000 net tons.[12]

The two materials flowing into the steelmaking furnaces are pig iron and scrap steel. Pig iron is produced primarily in blast furnaces

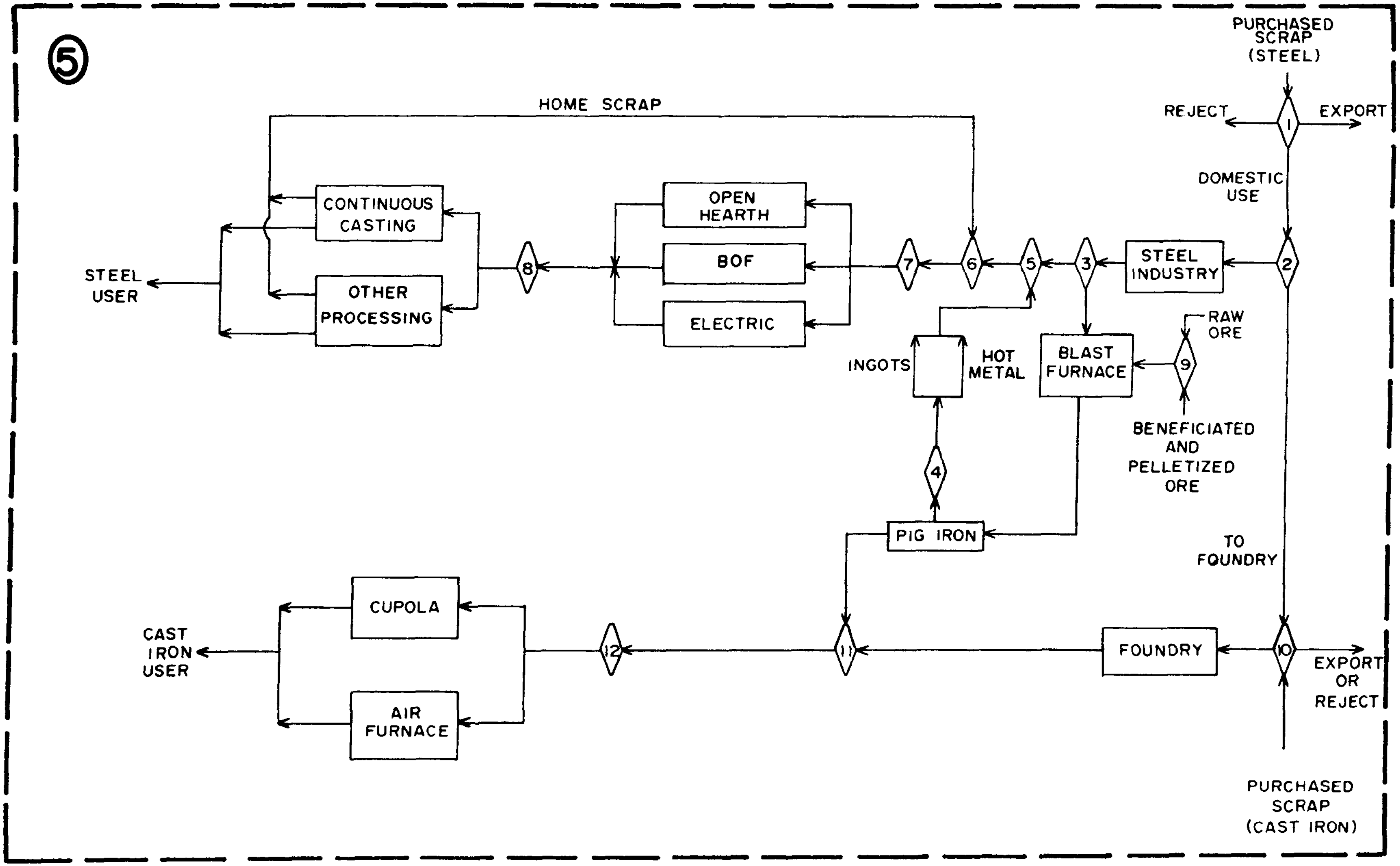

Figure 12. Scrap-end use.

through the heating of coke, limestone, and iron ore. Traditionally, the pig iron has been cast into ingots for transportation to the steel furnaces, where final refinement occurs (Decision 4, Figure 12).

In many steel plants, the reduction of iron ore to pig iron by the blast furnace occurs adjacent to the steel-producing facilities. There is an economy in transporting the pig iron to the steel furnaces in a molten state, rather than in casting ingots and transporting them solidified. In these integrated plants, the hot metal goes directly to the steel furnaces, requiring no reheating of the cold iron. Because of the resulting cost savings and the capital investment in the transporting system, the steel producer is less interested in purchasing cold scrap. In the production of steel by integrated plants, approximately 39 percent of the furnace charge is scrap, while in nonintegrated plants this percentage is about 80. The existence of these integrated plants should not have a significant effect on future scrap consumption, because in 1963, 92 percent of steel production was at integrated plants. Thus, the impact of the integrated plant has essentially been assimilated by the scrap industry.

At Decision 5, the producer establishes the ratio of scrap steel to pig iron consumed in the steel furnaces. This ratio depends on the type of furnace employed and thus depends on the decision made at point 7 in the flow diagram (Figure 12). The decision to use home scrap in the steel furnaces (point 6 in the diagram) is usually predetermined by the amount available, the cheap cost, and close proximity. The most crucial decision with regard to automobile scrap consumption is made at Decision 7. For the sake of background and simplicity, the three basic steel-making processes will be discussed individually:

Open Hearth. The open hearth furnace has been the primary method of producing steel for many decades.[23] In 1969, 60.9 million tons of steel were produced by the open-hearth method (accounting for 43.2 percent of total U.S. steel production).* The open hearth uses about 40 percent scrap in its furnace charge.

The trend in steelmaking is away from the open hearth and toward more efficient furnaces. (In 1959, the open hearth accounted for 86 percent of total U.S. steel production.) There is also a slight trend toward using less scrap in the open-hearth furnace charge.

Basic Oxygen Furnace (BOF). The basic oxygen furnace was introduced into the United States in 1954 and since then has made tremendous strides in capturing steel production capacity (mostly at the expense of the open hearth). The BOF is highly efficient and is almost to the point of revolutionizing steel production in the country.

In 1969, 60.2 million tons of steel were produced by the BOF, accounting for 42.7 percent of total U.S. steel production.[23] In 1970, BOF production surpassed steel production by open hearth. The scrap consumption by the BOF has consistently held at about 28 percent of the furnace charge. The percent of steel production by BOF's has risen dramatically in the past several years.

*Total steel production in 1969 is estimated to have been 139 million tons.

Electric Furnace. The electric furnace is substantially different from the other two furnaces. A relatively small capital investment is required in the facility. Because it relies totally on electric power and a 98 percent scrap charge, the criteria for the physical location of such a plant are different than for the BOF and open hearth.

The production of the electric furnace has risen steadily to 14.1 percent (19.9 million tons) of total production in 1969. The percentage of scrap in the furnace charge will remain at about 98 percent.

The steel as produced by one of these three methods is now ready for final preparation for the steel consumer (Decision 8, Figure 12). Conventionally, the molten steel is solidified and partially cooled so that it may be shaped to meet the specifications of the consumer (the lower branch at Decision 8 on the flow diagram). A more recent technique is continuous casting, wherein the molten steel is poured in the proper shape to meet the needs of the consumer. The continuous-casting technique produces 50 percent less home scrap and can cause increased use of prompt and obsolete scrap. This development will, therefore, increase somewhat the demand for automobile scrap.

Foundries

Iron foundries take pig iron, cast iron scrap, and scrap steel, melt them in a furnace, and then pour the product into molds to solidify in a given shape (Decisions 10 and 11). The resulting cast iron is more brittle and harder than steel and particularly suited to be machined for use where resistance to vibrations and shocks is required. With reference to the industry flow diagram, two major types of furnaces are used in producing cast iron (Decision 12). For the 15 years before 1963, the cupola furnace consistently accounted for about 91 percent of cast iron production (the air furnace accounting for essentially the remainder). It is assumed that this ratio holds at the present time.

During the 5-year period 1959-1963, the average annual cast iron production was 15.7 million tons. It is estimated that in 1970 the cast iron production was 18.3 million tons. During the 1959-1963 period, scrap ferrous metal accounted for about 74 percent of the charge in cupolas and about 85.5 percent of the charge in the air furnace. In the cupola, one-third of the scrap charge is steel and two-thirds is scrap cast iron. The same ratio of steel to cast iron for the air furnace being assumed, estimated scrap consumption for iron foundries in 1970 is shown (Table 11).

TABLE 11

ESTIMATED SCRAP CONSUMPTION FOR IRON FOUNDRIES IN 1970

	Cupola		Air furnace		
Material	Furnace charge (%)	Consumption (ton x 10^6)	Furnace charge (%)	Consumption (ton x 10^6)	Total Consumption (ton x 10^6)
Pig iron	26.0	4.33	14.5	0.24	4.57
Scrap steel	24.7	4.11	28.5	0.47	4.58
Scrap cast iron	49.3	8.21	57.0	0.94	9.15
Totals	100.0	16.65	100.0	1.65	18.30

There does not appear to be any recent major technological breakthrough in iron casting that will significantly change scrap consumption. The determining factor in scrap consumption appears to be the production of new cast iron. BDSA predicts that the industry production of cast iron will increase at a rate of 4.5 percent per year through 1975. If this estimate holds, there should be a continually increasing demand for obsolete scrap.

Cast iron production (million tons)	
1959-1963:	15.7 (yearly average)
1968:	17.9
1969:	18.8
1970:	18.3

Scrap cast iron elements (engine blocks, brake shoes, crankshafts, car wheels, etc.) cannot be used in the production of steel, because of the high percentage of carbon (3 percent) in cast iron (Decision 2, Figure 12). On the other hand, steel is used in foundries because of the less stringent requirements in composition of cast iron. Thus, the recycling of certain elements of a junked automobile depend solely on the iron foundries. But these elements are less objectionable than the hulk itself. It is hoped that the cast iron elements of an automobile will become a byproduct of the preparation of hulks for use by the steel industry. The market mechanism influencing the use of this byproduct must necessarily escape detailed analysis in this report.

Environmental Damage

Although numerous primary environmental problems are associated with the iron and steel mills and foundries, they are not directly related to automobile recycling. Minimal scrap demands, however, result in accumulations of automobile hulks in processors' and dismantlers' inventories and in increased abandoning of junked automobiles on public and private property--and this directly affects the environment.

Resource Conservation

Insufficient utilization of scrap automobiles automatically implies inefficient resource conservation. Every ton of scrap not used implies an additional amount of raw materials consumed. Complete utilization of automobile scrap can, therefore, mean maximum conservation of natural resources.

Key Decision Areas

To ensure adequate utilization of available and projected automobile scrap, several key decision areas must be analyzed to explain the complex trends that will affect future automobile scrap recycling. Three decision areas appear to be crucial (Decisions 7, 8, and 9). Decision 7 determines the type of process used and, therefore, the ultimate demand for scrap. Because the steel industry is in a period of change, it is important to examine what effect these changes will have on the consumption of scrap steel. The most apparent change is in the type of furnace used to produce steel. These developments will be discussed first and then, using furnace trends as a baseline, the effects of other trends will be examined. Statistics for 1969 steel production and projections for 1975 are shown (Table 12).

TABLE 12

PERCENT SCRAP USED IN AVERAGE FURNACE CHARGE

	Furnace type	% of steel production	x	% of furnace charge as scrap	=	Weighted percent of scrap used in average furnace charge
1969	Open hearth and Bessemer	43.2		40		17.3
	BOF	42.7		28		12.0
	Electric	14.1		98		13.8
	Totals	100.0				43.1
1975	Open hearth and Bessemer	20		40		8.0
	BOF	55		28		15.4
	Electric	25		98		24.5
	Totals	100				47.9

In 1969, 43.1 percent of the furnace charge was scrap, and it is estimated that 47.9 percent of the furnace charge will be scrap in 1975. Thus, there should be an increased demand for scrap in 1975 due solely to the expected shift in furnace production. On the assumption that there will be no increase in total steel production by 1975, the increase in scrap consumption over the 1969 consumption of 61 million tons would be 6.8 million tons. Of course, steel production will probably increase.

Decision 8 concerns the type of casting method used and therefore determines the quantity of home scrap available to compete with automobile scrap. It is estimated that 18.5 percent of all final steel preparation was by continuous casting in 1970. It is also estimated that by 1975 this percentage will rise to 38.5 percent. Continuous casting does reduce the quantity of home scrap by 50 percent. If the steel producer desires to maintain a constant input of the scrap proportion, then the scrap deficit will be made up by purchased scrap. If, because of less waste steel produced in the continuous-casting process, the producer desires to decrease the proportion of scrap in the charge, then the consumption of purchased scrap may not increase. The third alternative is to increase the proportion of pig iron in the charge in order to operate the furnace at capacity. In this case, the purchased scrap may not be increased. In any of these three cases, it appears the consumption of purchased scrap will not decrease and may increase.

Decision 9 affects the type of ore used in steel and foundry production. In many areas, low-quality iron ore is treated before reduction in the blast furnace. This treatment raises low-grade ore (taconite) from 25 percent iron to about 65 percent iron (equivalent to high-grade ore). The treated ore is formed into pellets for ease of handling and feeding to the blast furnace.

Demand for Automobile Scrap

In 1969, the gross domestic consumption of scrap steel was 61 million tons. Coupling this figure with 9 million tons of exports yields a total of 70 million tons of U.S. scrap consumed in 1969. Specific data are unavailable regarding the source of this quantity of scrap. Traditionally, the scrap source is as shown (Table 13).[8]

TABLE 13

SOURCES OF SCRAP

Source	% of total scrap consumed domestically
Home scrap	60
Prompt industrial	16
Obsolete	24

Since automobile scrap composes approximately 36 percent of the obsolete scrap, it amounts to only about 9 percent (approximately 5.5 million tons in 1969) of the total scrap used in domestic steel production. The scrap market apparently is not saturated with automobile scrap. On the basis of the general trends in the steel industry discussed earlier and the amount of automobile scrap currently used, it appears that the demand for scrap in the immediate future will remain strong, provided price and quality requirements are met.

SUMMARY OF AUTOMOBILE-RECYCLING PROBLEMS

The foregoing discussions have dealt in detail with the problems caused by the individual industries in the automobile cycle. In addition, the interrelationships have been briefly mentioned. In this section, the overview will again be taken to put the main problems in perspective and to delineate the key decisions and interrelationships that cause them.

Abandonment

The abandonment of vehicles on public and private property is a significant problem. In 1970, approximately 1,300,000 vehicles were abandoned. By 1975, approximately 1,500,000 vehicles will be abandoned if current trends are allowed to continue. Although these numbers represent a small percentage of total vehicles taken out of service, in absolute numbers they cannot be discounted. In fact, the accumulations of abandoned vehicles may exceed 8 million by 1980. Clearly, this problem must be remedied if the Nation's natural beauty is to be maintained. The actual abandonment is caused by the last owner's decision to leave it on public or private property rather than take it to an adequate disposal or recycling facility. This can be attributed to many factors, including lack of knowledge and rejection of vehicles by dismantlers and processors. The latter, as well as the owner's basic decision to abandon, is primarily due to the little or no positive value of the obsolete vehicle, or perhaps to the cost of disposing of it adequately. Any solution to the basic decision by the owner to abandon must either include the assurance of an obsolete vehicle's positive value for proper disposition or a severe and enforceable negative value (fine) for improper disposition. The latter would make the cost of abandonment higher than the cost of transportation.

These provisions to decrease or eliminate abandonment must also be augmented with a provision or incentive to encourage the removal of the current and projected accumulations of abandoned vehicles. As with the basic decision to abandon, the decision to collect is also hindered by the lack of substantive value of an abandoned vehicle. Only if the value exceeds the cost of collection will the accumulation of previously abandoned vehicles be reduced. In addition, titling and title transfer laws must be eased to reduce the lag time between abandonment and removal as well as to reduce the costs associated with title searches, impoundment periods, and owner notification. If the costs of removal and related legal aspects are reduced relative to the value of the abandoned vehicle, collection of abandoned vehicles by public or private agencies will be encouraged.

Vehicle Inventories

The second major problem area is related to the inventories of the industries involved in the automobile cycle. Although both processors and dismantlers have inventories of automobiles and automobile hulks, a detailed analysis indicated that the inventory of processors during 1965 was less than one-tenth of their total throughput of automobile hulks. This is well within levels required as a buffer against changes in supply. Dismantlers, on the other hand, had average inventories equivalent to 1-1/4 times their annual input. Even though they do require inventories, their ratio of inventories to throughput is clearly excessive, as is demonstrated by the total inventories dismantlers are estimated to possess. In 1965, the Department of Interior estimated these inventories as 6,570,000. As of 1970, this inventory was approximately 12 million. These large numbers clearly indicate a substantial inventory of unused resources as well as a blight on our landscape.

Although a complete elimination of this inventory is unreasonable and would unfairly hamper dismantlers' used-part sale operations, substantial reductions are possible. The Department of Commerce estimates that as much as half of the dismantlers' total inventories are no longer of value as parts. The dismantlers' decisions to accumulate and maintain these large inventories are based on a complex set of circumstances. Their decisions to keep the hulks after the parts have been removed, even though the hulks are readily available for processing, depend on the low scrap value of the hulks relative to the high cost of preparation for and transportation to processors. Preparation costs, a key factor, are increasing because of more stringent restrictions on open burning of the vehicles to remove contaminants and because processors insist on stripped vehicles. To encourage the reduction of automobile hulk inventories, either the value of the vehicle to the processor must be high enough to allow him to pay dismantlers the high cost of hand stripping or his method of processing must be made largely independent of preliminary stripping by dismantlers. In addition, the costs of transport to processors could be reduced through more economical transportation techniques or shorter distances between dismantlers and processors. This problem is critical in rural areas, where distances to processors can be several hundred miles. A reduction in these hulk inventories as well as in inventories of undismantled cars can also be brought about by making the costs of inventory higher than their expected value from parts and so forth.

Incomplete Reutilization by Mills and Foundries

The final problem area depends on the steel mill and foundry industries' desire to utilize automotive scrap. The detailed study indicated that exports and mill and foundry demand potentially far exceed total scrap available. Current trends and projected changes indicate that this will continue at least through 1975 and probably far beyond. Automotive scrap is but a small percentage of total scrap used and, as such, represents no significant effect on usage. Unfortunately, it is also one of the least desirable forms of scrap and is, therefore, the first to be reduced in times of decreased iron and steel production. Moreover, its low quality makes prices paid to processors of bales very low, and this low price is reflected throughout the scrap cycle. Hence, these factors can cause the cycle to stop, thus increasing the number of vehicles abandoned on our streets.

The decision to use automobile scrap is determined by price and quality. Certainly, a reduced price of scrap relative to that of competing raw ore and pellets can increase usage, although this is unlikely without at least a moderate increase in scrap quality. Currently available techniques can shred scrap and separate out nonferrous components to an acceptable degree. Unfortunately, this is not being pursued by all or even most of the processing industry. Of the 500 to 1,000 processors, only 75 to 85 are using shredding equipment, and these are only in the densely populated areas of the country. The remainder are using balers to produce low-quality scrap. With the low-quality baling operations in rural areas, low prices for automobile hulks have increased the inventory problems in these areas. Incentives to scrap processors to produce good-quality scrap, in combination with reduced costs of automobile scrap production or transportation, can ensure full utilization of all automobile scrap. Encouragement to locate in more rural areas can also reduce the inventory problems in the areas where they are most pressing. Unfortunately, shredding plants need large quantities of cars and large capital investments. If these were, nevertheless, encouraged, higher prices for hulks could be obtained and more stability against demand fluctuations maintained.

The increased utilization of automobile scrap will of necessity aid in the reduction or at least the stabilization of inventory hulks at the processor and dismantling levels. There is, however, no assurance about the time period or magnitude of the effect of increased demand by steel mills and foundries.

PROBLEM SOLUTION

The three main problem areas in the automobile cycle have been delineated and the decisions of consumers, processors, dismantlers, steel manufacturers, and others, that caused them have been discussed.

In addition, the barriers to or causes of these decisions were illustrated. Unfortunately, the existence of the problems indicates that the free market has been unable to reduce or rectify the problem. Additional action is, therefore, required if these key decisions are to be changed and the problems rectified.

Basically there are four main types of tactics: (1) economic incentives; (2) regulatory action; (3) education; (4) research and development. Within each of these broad categories are numerous specific tactics that can be applied to one or more of the main industry segments in the automobile cycle. An extensive, but by no means exhaustive, list of specific tactics, grouped by type and briefly explained, is presented in Appendix A.

In general, any one tactic will not alleviate all the problems. Tactics can, however, be combined in innumerable ways to form basic strategies to alleviate all the environmental and resource conservation problems. Many combinations that can alleviate one or more problems may, however, simultaneously cause some undesirable effects in the automobile cycle. This possibility can be minimized by evaluating the impact of proposed strategies on all the key decision points throughout the automobile cycle.

To determine the strategy to be selected, four main objectives upon which each may be evaluated have been proposed: (1) minimize environmental damage; (2) conserve natural resources; (3) minimize economic disruption; (4) simplify administrative procedures. Each of these major objectives is now discussed in detail.

Minimize Environmental Damage

Environmental damage includes scenic blight from motor vehicles abandoned on public and private property and dismantlers' yards; harborage of rats and other vectors in out-of-service vehicles; air pollution from burning by dismantlers or processors; water pollution from runoffs of motor vehicle oil and grease; and solid waste from various parts of the motor vehicle cycle. To be effective in obtaining this objective, a strategy must not only have a high probability of reducing these factors but must also do so in a relatively short period of time.

Conserve Natural Resources

It is desirable to recycle the various materials contained in out-of-service vehicles as well as to reduce the amount of land used to store them. A strategy that achieves this objective must recycle as much of the ferrous and nonferrous materials as practical in both the accumulated inventories and all future vehicles that go out of service.

Minimize Economic Disruption

Economic disruption includes undue interference with the markets for new and used cars, used parts, out-of-service motor vehicles, and processed motor vehicle scrap. The economic burden imposed in order to improve the motor vehicle cycle should not be larger than necessary, and its distribution should be equitable. The productive capacity of any segment of the cycle should not be stimulated beyond what long-run conditions will support. Hence, a strategy must effectively reduce pollution and conserve natural resources without causing worse problems in the rest of the economy.

Simplify Administrative Procedures

The number of people and amount of money necessary to implement the suggested program for improving the motor vehicle cycle should be as small as possible. Reporting requirements and record keeping should be minimized, as should enforcement responsibilities. If administration is complicated and expensive or enforcement is impossible, then the related strategy is of questionable value.

Selecting the Best Strategy

Once alternative strategies have been formulated and the objectives have been defined, a panel of experts can use one of the many decision-making techniques available to select the best strategy. Some possible strategies are presented and discussed in Appendix B. The panel could, for example, rank the objectives and obtain relative weights for each. In turn, each strategy could be rated in terms of how well it meets each objective. The objective and strategy weights obtained would then be cross-multiplied and summed to obtain an overall rating for each strategy. The specific mathematical procedure will not be discussed further, because it is the creative aspects of this decision-making procedure that should be emphasized. In discussing objective ratings, the panel of experts will shed light on the really important aspects of the abandoned automobile problem. In rating each strategy with respect to how well it will meet each objective, the strengths and weaknesses of each proposed solution become clear. It is possible that strategies can then be synthesized and prove superior to those originally proposed.

Conclusion

There are many interrelated decisions that affect the final disposition of vehicles going out of service and, in many cases, result in their being abandoned. Although many of the estimates in this report are based on 1965 data, it is obvious that the abandoned vehicle problem persists. Strategies can be formulated to alleviate the problem, but this is not as simple a task as might be expected.

This report has analyzed the entire automobile cycle and pinpointed the key areas to which any successful strategy must be directed. Unfortunately, each possible solution can have undesirable consequences. A procedure for evaluating strategies has, therefore, also been discussed that allows the achieving of desired effects while minimizing undesirable consequences. This report provides the overall framework and analytical tools needed to evaluate alternate strategies and select the one that is most appropriate.

APPENDIX A

TACTICS: THE PROBLEM-SOLVING TOOLS

I. Economic Incentives

Economic tactics are inducements that influence the flow of funds into and out of specific segments of a given industry to bring about desired changes. These incentives can be either positive or negative and are further classified as revenue sources and revenue uses.

I.A. *Revenue Sources*. Government can acquire funds to finance new programs by taxation, reduction of current payments or involvements, monetary penalties, or elimination of subsidies and price supports.

I.A.1. *Domestic-automobile-manufacturing tax*. A Federal tax would be levied on all new cars manufactured and would be used to supplement the cost of disposing of or recycling the cars. The tax could be used as a positive action if it were assessed on a sliding scale to reflect the design and relative adaptation of the vehicle to improve its potential for recycling.

I.A.2. *Imported-automobile tax*. This would be the same as the domestic-automobile-manufacturing tax, except that it would be assessed on all imported automobiles at the port entry.

I.A.3. *Dealers' new-car sales tax.* This would be similar to the first two taxes, but the burden of payment would be placed on the middleman (dealer) who has little capability to change the recycle patterns or improve environmental insult. A tax on the dealer, then, is probably inferior to one on the manufacturer. It would, moreover, be more difficult to administer, given the large number of dealers.

I.A.4. *Used-car sales tax.* This would be the same as that on new cars except that it would be assessed on used cars.

I.A.5. *Licensing tax.* This would be a State tax collected at time of licensing of all new and used vehicles on an annual basis. It could be collected through already established channels, and the administrative procedure could be minimized thereby. It would place the burden of payment on the consumer and would be distributed among all owners of operated vehicles. If administered on the Federal level, more administration and new channels would be required.

I.A.6. *Gasoline tax.* This would be a Federal tax based on the sales price of each gallon of gasoline and be similar to other Federal excise taxes on gasoline. It too could be collected through already established channels, although there would be a large number of individual transactions. The mechanism for redistribution to the States is in existence. Resistance might be strong on an item already burdened by State and Federal taxes on road use.

I.A.7. *Competitive natural resources tax.* This would be a Federal tax assessed on raw materials (iron ore, coke, and limestone) that directly or indirectly compete with secondary materials from automobile recycling. This would be a direct tax on raw materials to bring their cost of development in line with the costs associated with reclaiming scrap steel and other recyclable materials. It might have an impact on a segment of the economy far larger than that involved in the automobile cycle.

I.A.8. *Elimination of natural resources subsidies.* This would be reduction or elimination of depletion allowances for selected minerals and raw materials and would thereby indirectly encourage recycling of scrap steel and directly force responsibilities for improving environmental quality on the original extractor or developer. This tactic would directly influence conservation of natural resources and restoration of disturbed environments. It would also have, however, large-scale effects on the national economy.

I.A.9. *Fines and penalties on abandonment.* This would be a penalty inflicted on any individual (last owner) accused and convicted of abandoning an obsolete or inoperable vehicle on public or private property. This negative tactic to reduce abandonment would be effective only if there were a high probability of enforcement.

I.A.10. *Fines and penalties on excess inventories.* This would be a penalty inflicted on any collector, dismantler, or processor for maintaining inventories of discarded vehicles or hulks in an excessive amount and for long periods of time.

I.A.11. *Consumer-returnable deposit.* A buyer of any new or used vehicle would be charged a fixed fee that would be placed in a special fund for later return to him. The deposit would be returned to a vehicle owner upon submission of proper evidence that his old car had been released to a recognized used car dealer, collector, dismantler, or processor. In essence, the deposit would guarantee a positive value for any discarded vehicle and, if it were large enough, it would reduce abandonments. Interest would be earned over the time lag.

I.B. *Revenue uses.* Revenue obtained by taxation, penalties, and interest could be used to encourage, support, or subsidize desirable industries or to encourage increased consideration of and action toward environmental problems and recycling of secondary materials.

I.B.1. *Bounty on abandoned automobiles.* This would be a fixed price paid to anyone who collected an abandoned automobile from public or private property and arranged for its proper disposal or recycling. This would be a positive incentive to individuals, collectors, dismantlers, processors, and public authorities to collect all abandoned vehicles and speed their movement through the scrap cycle. Effectiveness would depend on the size of the bounty and on local conditions. The level of administration would depend on the safeguards against fraud.

I.B.2. *Bounty on all automobiles given to dismantler or processor.* A fixed price would be paid to anyone who gave his discarded automobile to a recognized dismantler or processor. This bounty would be highly inefficient since recovery would be paid for all vehicles--whether or not they were abandoned. Administration again would depend on the tolerable level of fraud.

I.B.3. *Subsidy to dismantler.* A flexible payment would be made to the dismantler to allow him to accept all abandoned vehicles, to abide by accepted standards, and to serve as a responsible link in the recycling chain--and yet cover his cost of operation and earn a satisfactory return. As a subsidy, it would automatically upset the free-market mechanism. It would force a balance between the two objectives of minimizing economic disruption and minimizing environmental insult. The large numbers of firms would make administration costly.

I.B.4. *Subsidy to scrap processor.* This would be similar to the subsidy to dismantlers, except that indirect payments would be made to the processor for using advanced technology and adequately processing all vehicles and hulks coming to him. Owing to the large quantities of other scrap products handled, fraud would be possible. This mechanism could ensure growth of the key industry segment.

I.B.5. *Subsidy to steel mills.* This would be similar to the two subsidies just discussed, except that indirect payments would be made to the steel mills for using processes that favor acceptance of processed scrap steel over home scrap or raw material. It would be difficult to administer and enforce.

I.B.6. *Subsidy to scrap exporter.* A payment would be made to the scrap export broker to make the price of U.S. scrap more competitive on the world market. This could aid the balance of payments but might have international repercussions.

I.B.7. *Low-interest loans to scrap processor.* These would be made for installation and use of advanced equipment and technology to handle larger quantities of vehicle hulks and to process higher grade scrap steel. This, in turn, would make the higher grade processed scrap available in larger and more consistent quantities and would enable it to draw a higher price because of its increased value to the steel mill. This tactic would not tend to upset the free-market mechanism significantly. The effect on the cycle would not, however, be immediate.

I.B.8. *Low-interest loans to steel mills for electric furnaces.* Electric furnaces accept a very high percentage of scrap steel (approximately 95 to 98 percent). Because, however, automobile scrap is only a small percentage of total scrap used, this mechanism might be inefficient. Moreover, large loan amounts would probably be involved.

I.B.9. *Establishment of free disposal areas.* A program would be operated by a public authority whereby a private citizen could bring in his vehicle for subsequent recycling or proper disposal. This would be useful when private industry failed to take the initiative.

I.B.10. *Government stockpiling of automobiles.* The government (either State or local) would accept the responsibility for collecting and stockpiling abandoned vehicles when the free-market mechanism failed to support the complete cycle. This would at least control the abandonment problem, although unsightly public stockpile yards might develop, caused by a small demand by dismantlers and processors for discarded vehicles. Administrative responsibilities would be great.

I.B.11. *Government differential-price purchasing of high-scrap steel products.* The government would pay higher prices for products having high percentages of scrap steel. This would tend to reduce the demand for nonscrap steel production and force steelmakers to consider using more processed scrap. In essence, this would be a discriminatory buying policy favoring scrap steel products. This might, however, increase demand for low-quality automobile scrap only sightly.

I.B.12. *Payment for better automobile composition or design.* A payment would be made to automobile manufacturers to conduct research on and development of technical changes that could improve and increase the ultimate recycling of ferrous and nonferrous materials. In essence, government would subsidize research and development contributing to improved environmental quality and reducing environmental insult.

I.B.13. *Funded educational program.* The government would support mass educational and informational programs publicizing new efforts for solving critical problems. Car owners could be made aware of proper channels of recycle, of those interested in collecting and buying discarded vehicles, and of specific new automobiles having favorable design features.

I.B.14. *Accelerated depreciation for steel mills.* This would be a tax writeoff for capital-intensive equipment using large quantities of scrap steel. This would have the same drawbacks as the low-interest loans.

I.B.15. *Accelerated depreciation for processors.* This would be a tax writeoff for capital-intensive equipment producing higher grade scrap and accepting larger quantities of discarded vehicles and hulks. It would also support new technology for recovering other nonferrous material from processed vehicles.

II. Regulatory Actions

The precedent for intervention by government in affairs of private enterprise is justified on grounds that regulation will result in health, safety, or consumer protection; maintenance of a free but fair economic system; conversion of important natural resources; support of industries vital to national welfare; maintenance of the Nation's defense posture; control of monopolies or semimonopolies; and control of industries closely linked to defense preparedness like air, water, and land transportation. Recently, regulations have been proposed and introduced to deal with environmental problems where they affect our future health and safety and our aesthetic enjoyment, and the problems encountered with automobile recycling are in this category.

Regulatory actions are, in essence, government sanctions and controls that impose involuntary constraints upon specified activities. They should be used only as a last resort to accomplish objectives that are beneficial to public welfare and to offer solutions to critical problems.

II.1. *Fines for abandonment.* These would be legal penalties that could take the form of cash remission or potential imprisonment for those who abandon automobiles on public and private property. This would be a punitive measure to thwart further environmental blight. The administrative procedure for enforcing these fines might be somewhat complicated, expensive, and time consuming. The technique would be useful only if enforceability were obtainable at moderate cost and if potential abandoners were cognizant of that fact.

11.2. *Uniform titles and eased transfers of ownership.* This would be a tactic designed to facilitate the flow of abandoned vehicles from public and private property into the cycle. At present, transfers of ownership are time consuming and costly. Easing of titling restrictions would reduce the costs involved in processing low value, abandoned vehicles. This would encourage their removal by either public or private operations.

11.3. *Composition of new automobiles.* A Federal standard would reduce or ban the use of certain materials in new vehicles. It is apparent that a reduction in the percentage of copper, which is particularly offensive to steelmaking processes, would lead to higher quality processed scrap steel. Other materials, such as plastics, textiles, and nonferrous materials, might be designed and used so as to facilitate easy removal and recycling. This tactic would, however, be potentially disruptive as well as administratively complicated.

11.4. *Quotas on material resources.* When it is determined that raw material sources are being depleted at a rapid rate or that usage of raw materials is severely restricting usage of secondary materials, the Federal government could impose quotas on material resources. This tactic would be most restrictive to private industry and might well induce unjustifiable hardships on the industries involved and perhaps on the overall economy.

11.5. *Import quota on raw ore.* A Federal quota would be imposed on the importation of raw ores (iron ore, coke, and limestone) to prevent flooding the domestic market with low-cost ores from other countries. This mechanism, in the past, has been used to protect domestic industries that cannot compete effectively in the world market; to maintain balance of payments equilibrium; to protect our national defense preparedness; and to distribute national purchases according to favored-nations agreements. Import quotas on raw ores would have broad significance and would only indirectly influence recycling of vehicles. Their implementation might also have international repercussions.

11.6. *Quota on number of new automobiles or total tons of steel used therein.* A Federal quota would limit the number of vehicles manufactured or would limit the tons of steel used in their manufacture. This would certainly control the quantity of vehicles requiring recycling, but the political implications and resultant economic disruption would not be justified.

11.7. *Hulk inventory restrictions.* This would be a regulation imposed on dismantlers and processors to limit the size of their hulk inventories. Conceivably, a minimum inventory turnover rate would be established on a gradually increasing scale. This tactic could well be an effective means of controlling inventories of discarded vehicles, although the procedure for enforcing standards might be difficult to administer, and disruption of the dismantling industry would be likely.

II.8. *Differential interstate freight rate changes.* This tactic would involve reassessment of freight rate structures to bring the cost of transporting vehicles, hulks, and processed scrap more in line with the cost of shipping raw ores. More competitive scrap prices would encourage more scrap use.

II.9. *Restrictions on percent scrap for government purchase.* The government, in its buying decisions, would restrict purchase to steel products having a specified minimum percent scrap content. This might be hard to administer and its effect on automobile scrap consumption might well be negligible.

II.10. *Screening of inventories.* Licensing of dismantlers and processors would require that they screen their facilities by proper fencing or foliage and thus shield their operations from public view and enhance the aesthetic surroundings. In many large graveyards and dismantlers' facilities, however, this might be impractical.

III. Education

Although economic incentives, regulations, and development of improved techniques for recycling and reuse are promising, good public and private educational programs are essential.

III.1. *Develop public information campaigns to increase consumer awareness.* Support of public education through Federal- and State-funded campaigns would increase awareness of the need to solve environmental problems. Television, radio, and newspaper advertising could stimulate awareness of new laws and of contact points for returning discarded vehicles. Speakers meeting with community groups would focus attention on the need for and significance of action programs.

III.2. *Training programs for industry and government personnel.* Federal and State support of training programs would be designed to educate industry and government employees in acceptable ways of recycling automobiles and of developing improved techniques for operations.

IV. Research and Development

To provide for development of more efficient production processes, more durable and consumable automobiles, improved systems for complete recycling, and motivation of intermediaries to perform needed action, appropriate research and development programs are essential.

IV.1. *Develop new technology to make scrap contaminant removal easier.* Federal funds would support research leading to design and implementation of module electrical and mechanical systems that could be removed easily from vehicle bodies.

IV.2. *Develop new technology to use fully and recycle nonferrous automobile solid waste (including tires).* Federal research grants and contracts would aid private industry and research-oriented firms.

IV.3. *Develop new technology to reduce transport costs of automobile hulks.* The Federal government would support research leading to greater hulk density or improved systems for handling and transporting hulks.

IV.4. *Develop improved data sources on quantities and locations of junked and abandoned vehicles.* Support would be given to a material data network that identifies vehicles according to serial number, type, model, etc., and cross-classifies them according to location and proximity to processing facilities.

IV.5. *Develop new design parameters and materials for automobiles.* Support would be given to research leading to development of copperless vehicles, and usage and design of materials more amenable to complete recycling and reusage.

IV.6. *Fund automobile demonstration project on results of these research projects.* Through the use of Federal demonstration grants, new concepts, processes, equipment, and systems would be demonstrated.

This list of tactics can be applied to remedy (to some degree) one or more of the three major problems in the automobile cycle: (1) abandonment; (2) hulk inventories; (3) incomplete automobile scrap reutilization. Each basic tactic is related to the industry segment where it may be potentially employed to alleviate the three problems (Tables A-1, A-2, A-3).

TABLE A-1

AUTOMOBILE ABANDONMENT PROBLEM

Type	Auto Mfg	Consumer	Government	Dismantler	Processor	Scrap-end use
I. Economic Incentives I.A. Revenue Sources	I.A. 1,2,3	I.A. 1,2,3,4, 5,6,8,11				
I. Economic Incentives I.B. Revenue Uses		I.B. 2,13	I.B. 1,9,10, 13	I.B. 1,2	I.B. 1,2	
II. Regulatory Actions	II. 6	II.1	II.2	II.2		
III. Education		III.1	III.2			
IV. Research and Development		IV.4	IV.4			

TABLE A-2

DISUSED-AUTOMOBILE INVENTORY PROBLEM

Type	Auto Mfg	Consumer	Government	Dismantler	Processor	Scrap-end use
I. Economic Incentives I.A. Revenue Sources				I.A.9	I.A.9	
I. Economic Incentives I.B. Revenue Uses			I.B.10	I.B.7	I.B.8	
II. Regulatory Actions			II.2	II.2,7,8, 10	II.7,8,10	II.9
III. Education				III.2		
IV. Research and Development				IV.3,4	IV.4	

TABLE A-3

INCOMPLETE AUTOMOBILE SCRAP UTILIZATION PROBLEM

Type	Auto Mfg	Consumer	Government	Dismantler	Processor	Scrap-end use
I. Economic Incentives I.A. Revenue		I.A.11				I.A.7,10
I. Economic Incentives I.B.	I.B.12			I.B.3	I.B.1,4,7, 11,15	I.B.5,6,8, 11,14
II. Regulatory Actions	II.3,6			II.8	II.8	II.4,5,9
III. Education					III.2	III.2
IV. Research and Development	IV.5		IV.2	IV.1,2	IV.1,2	IV.1

APPENDIX B

STRATEGIES: THE MASTER PLAN

STRATEGY A

This strategy is based on the assumption that direct actions must be taken to ensure that abandoned automobiles are no longer a problem, inventories are reduced to acceptable levels, and potentially valuable materials are fully recycled.

I. Economic Incentives

1.A. *Revenue Sources*

1. An annual Federal tax of $2 would be assessed on all licensed vehicles and payable to a special fund.

2. Automobile manufacturers would be charged a recycle fee of $20.00 for each new vehicle manufactured and sold--a fee payable to a special fund.

3. Provision would be made for taxing excessive inventories of collectors, dismantlers, and processors at the rate of $5 per excess vehicle per year. A minimum inventory turnover rate would be established on a gradually increasing scale.

1.B. *Revenue Uses*

1. A fixed return of $20 would be paid to the last registered owner of a recycled vehicle (verified by a "certificate of delivery" to a licensed collector).

2. A fixed amount of $5 would be paid to a collector or dismantler for each vehicle hulk leaving his inventory and sold to a scrap processor.

3. Low-interest loans would be provided to processors for installation of improved processes.

II. Administrative and Regulatory Actions

1. Ease titling restrictions--all obsolete or inoperable vehicles with assessed valuation of less than $150 and determined to be a public nuisance may be regarded as not having substantial value and therefore subject to collection by licensed collectors.

2. License all collectors, dismantlers, and processors of discarded vehicles.

3. Provide for disbursement of funds to "last owners" and "dismantlers" through existing channels of government. Support State government for administration of funds.

4. Provide for a maximum fine of $500 or 30 days in jail, or both, for those who discard vehicles on public and private property and along roadways.

5. Negotiate with railroads and trucking lines through ICC for more equitable transportation rates for shipment of vehicle hulks and processed steel scrap.

6. Eliminate mineral depletion allowances to make steel scrap more competitive with raw ores and, if necessary, provide for negative depletion allowances to force environmental restoration on original extractor or developer.

7. Establish a Federal Vehicle Recycle Committee to review progress, allocate funds, plan for future actions, and make changes in existing programs as deemed necessary.

III. Education Actions

1. Provide for development and use of public information and education programs through mass media, public presentations, etc.

2. Provide for training of collectors, dismantlers, and processors.

IV. Research and Development Actions

1. Support research on and development of new and improved processes to convert discarded vehicles to high-quality steel.

2. Support research on and development of new and improved processes to recycle nonferrous materials.

3. Support research to study ways of improving environmental, social, and political systems where relevant.

Strategy A has potential for effectively accomplishing the following four key objectives.

Minimize Environmental Damage

The problem of unsightly and hazardous abandoned automobiles would be attacked by paying the last owner of a vehicle $20 for its proper return. If he still failed to return his inoperable vehicle, he could be subjected to a heavy penalty. The problem of excessive inventories of vehicle hulks would be approached by paying collectors and dismantlers for turning over their inventories at a rapid rate and supplying hulks to scrap processors. Furthermore, a tax would be levied on vehicles in excess still remaining in inventories. Easing of titling restrictions would accelerate the recycling process of returning abandoned vehicles to profitable reuse. Licensing of operators would force certain performance standards.

Conserve Natural Resources

The primary mechanism for conserving natural resources would be to eliminate depletion allowances for the purpose of forcing original developers of raw minerals to be responsible for environmental depletion and for restoring the land and the environment to its natural or improved state. This in conjunction with reduced freight rates and other positive incentives would have the effect of making scrap more competitive with raw ores. Manufacturers would be induced to consider redesign of new vehicles by reducing their recycle fee through use of improved, recyclable materials.

Minimize Economic Disruption

The procedure for obtaining funds to support a Federal vehicle recycle program would call for a balanced assessment on both manufacturers and consumers. The consumer, in licensing his vehicle, would be required to provide for its proper recycle through minimal annual payments. This money would be returned to him in the form of a guaranteed payment for his adequately discarded vehicle. The manufacturer would be charged a recycle fee for each vehicle sold, forcing him to share responsibility for its ultimate reuse. If he were to improve a vehicle's design to permit more effective recycle, then the $20 fixed charge could be reduced accordingly to a minimum of $10. There would be no direct price support (determined unwanted and unnecessary) of scrap prices. Nor would the private industries be severely upset to the point that small operators would be forced out of business. It is recognized, however, that a reduction or elimination of mineral depletion allowances could cause significant readjustments in the steel industry. It is important to face up to the fact that primary industries must assume responsibility for preserving environmental quality. Scrap processors would be rewarded for improved processes by granting of low-interest loans and reduced freight rates.

Simplify Administrative Procedures

A Federal committee of minimal size but of flexible authority would be set up to monitor the Federal system and make adjustments where necessary. For the purpose of collecting and disbursing funds, the existing mechanisms of State and local government would be used much the same as at present. Of course, easing of titling restrictions would reduce the legal, administrative, and temporal difficulties involved in obtaining and recycling discarded vehicles.

STRATEGY B

This strategy is based upon the assumption that if automobile hulks were provided, processors and the steel manufacturers would use the processed scrap. It is necessary to take direct action to collect vehicles and provide penalties for abandoned vehicles.

I. Economic Incentives

I.A. *Revenue Sources*

1. Increase excise tax on gasoline from $0.04 to $0.05 (Federal level).

2. Fines for vehicle abandonment (State level).

3. Vehicle sale (local level).

4. License fee (local level).

I.B. *Revenue Uses*

1. Provide localities with funds to collect vehicles (local level).

2. Provide localities with funds to establish vehicle storage areas before vehicle is sold to processor (local level).

3. Provide money (10 percent gasoline revenue) for research (Federal level).

4. Provide money for program administration (local, State, and Federal levels).

II. Administrative and Regulatory Actions

1. Set up Federal Vehicle Recycling Committee within existing agency (Federal level).

2. Establish State staff to be responsible for vehicle recycling (State level).

3. Establish local staff of consultants to develop, plan, and provide for monitoring surveillance system (local level).

4. Ease titling restrictions--any vehicle under $50 not licensed or having a storage permit can be removed from public or private property (State level).

5. Provide a vehicle identification/ownership mechanism (Federal-State levels).

6. Require licensing of all dismantlers, processors, and collectors of discarded vehicles (local level).

7. Establish a $200 fine for abandoning vehicles (State level).

III. Education

1. Inform public of the mechanism for vehicle recycling and of penalties for abandonment (State-local levels).

IV. Research and Development

1. Support research to improve technology in the area of steel scrap (Federal level).

2. Support research to investigate ways to recover nonferrous metals and materials from vehicles (Federal level).

3. Support research to investigate methods to make a car easier to scrap (Federal level).

Minimize Environmental Damage

The problem of the discarded/unwanted vehicle would be eliminated by providing a mechanism for collecting and storing vehicles. To encourage people to use the system a fine would be established to make vehicle abandonment costly. The storage area would be shielded so as to prevent an unsightly appearance. The stored vehicles would be sold directly to the processor to prevent the dismantler from accepting any unwanted vehicles.

Conserve Natural Resources

Natural resources would be conserved in two ways: first, by removing the existing inventory of vehicles scattered throughout the country and getting them into the scrap cycle; second, by providing a mechanism to keep the unwanted vehicle in the scrap cycle by establishing a collection and distribution system.

Minimize Economic Disruption

No money would be spent for subsidies or payments to make some material appear more attractive. Hence the price structure would remain the same. The supply of vehicles to the processor would not be greatly affected, since the excess vehicles collected would be stored and sold only to fill the processor's capacity. The dismantler could still sell his vehicles to the processor at his existing rate.

Simplify Administrative Procedures

The strategy was formulated with ease of administration in mind. The gasoline revenue would be collected by using the existing excise tax structure. The funds would also be distributed to the States by using the same system. Federal participation would be by a committee within an existing agency. Research would be channeled through an existing agency by earmarking of funds for motor vehicle research. State administration would use its existing system but would merely increase the staffing. Local administration would use its existing sanitation department.

STRATEGY C

I. Economic Incentives

I.A. *Revenue Sources*

1. One-time $10 fee, added on to State motor vehicle registration fees, would be established as a Federal recycling fund.

2. A blue ribbon committee would be given power to levy $1 to $3 add-on to registrations if warranted in future years.

I.B. *Revenue Uses*

1. Local governments would be reimbursed for collecting, storing, and delivering abandoned motor vehicles to processors.

2. For cities not within a reasonable distance of processor, flatteners would be provided and cars sent by most economical means to a processor.

3. Railroads or other freight company would be subsidized for moving flattened motor vehicles. Subsidy would vary on regional basis as necessary.

4. Education and research would be provided by the Federal government.

5. Local governments would be reimbursed for the net cost of licensing dismantlers and processors as well as for surveillance.

6. Local governments would be reimbursed for moving a dismantler's unwanted hulk inventories to a processor.

II. Regulation

1. State legislation would enable local government to take title to abandoned motor vehicles.

2. Legislation would be enacted permitting fines for motor vehicles abandoned on public property and storage fees on private property.

3. Legislation would empower local governments to set standards for dismantlers and processors with respect to environmental insult, including unsightly inventories.

4. ICC would be encouraged to decrease freight rates on processed motor vehicle scrap in line with rates for iron ore.

III. Education

Citizens would be made aware of local government vehicle collection services, fines, and storage fees.

IV. Research and Development

Research and development for methods of recycling nonferrous materials would be supported.

Minimize Environmental Damage

This strategy would empower local government to take direct action against scenic blight caused by abandoned motor vehicles on public and private property. It would further enable local government to regulate the environmental aspects of dismantling and processing. By delivering to the processor, the local government would avoid increasing dismantlers' unwanted inventories. Local governments could also take direct action to remove inventories left by dismantlers who choose to go out of business. Subsidizing freight rates for moving flattened hulks would help reduce dismantlers' inventories as will adjusting freight rates for processed motor vehicle scrap.

Conserve Natural Resources

By reimbursing local governments for delivery to processors rather than, say, for landfilling disused motor vehicles, the ferrous content of the vehicles would be recycled. Demand for processed scrap would be expected to be sufficient if vehicles could be delivered to processors. Adjustment of freight rates that tend to discriminate against processed scrap in favor of iron ore resources would give added assurance that vehicles delivered to processors would be reclaimed. Research to develop new ways to reclaim nonferrous materials would, in the long run, make less and less the portion of disused automobiles that became solid waste. Subsidies to railroads for hauling motor vehicle hulks would tend to reduce the amount of land needed by dismantlers.

Minimize Economic Disruption

The amount of money needed for this strategy would be minimal since it is directed only to problem areas. The burden would fall directly on car owners. This might, in fact, lighten their load since no overhead would have to be paid to the motor vehicle manufacturers and dealers. The markets for new and used motor vehicles, raw steel, and foundry iron would not be affected by this strategy. The supply of processed scrap might be stimulated somewhat but not enough to cause overcapacity. The heaviest burden would fall on the dismantler forced to improve his operating conditions. For the marginal dismantler, entering or leaving this occupation would be of minimal consequence. That is, a one- or two-man-operation processor with a small capital investment might find alternative employment much easier than, say, a processor with a $2 million investment. Here we must face squarely the dilemma that the small businessman is the one who tends to insult the environment. Either the dismantler uses his ingenuity to meet licensing requirements or he goes out of business. He would, of course, receive some help from subsidized freight rates on hulks. Some benefit from more equitable processed-scrap freight rates might reach him.

In addition, some money from the recycling fund might be used to help the small dismantler meet local licensing requirements as an adjustment to this strategy.

Simplify Administrative Procedures

Revenue collection would use existing State mechanisms and be adjusted annually. Implementation and surveillance would be at the local level, where it must be to have effective action. At the Federal level, machinery must be set up to deal with local governments. Not all local governments, however, can be expected to participate. New York City, for example, is currently being paid for the privilege of removing abandoned automobiles from the streets. Not all of the 10 to 20 percent of cars out of service annually that are abandoned would be involved. Only those presenting a problem would be touched by Federal funds through local government. Cars with sufficient value to be of interest to dismantlers would be handled as they are now.

STRATEGY D

I. Economic Incentives

I.A. *Revenue Sources*

1. Increase in gasoline tax of $0.005 (or a Federal registration fee of $5.00 per vehicle) would be levied; each State could receive as much as one-half of its collected share provided the regulatory requirements shown here were implemented within 1 year.

2. As much as $10.00 per newly manufactured car in 1972 and thereafter would be payable by manufacturer unless copper content of vehicle is below acceptable limits as set by the Bureau of Mines to be measured by a technique of its approval. As much as an additional $10.00 per newly manufactured car would be payable in 1975 unless nonrecyclable nonferrous elements were reduced to an acceptable level as set by governing authority.

I.B. *Revenue Uses*

1. Federal share of gasoline tax would be applied in the following priorities.

a. Low-interest loans to qualified processor would be determined by Bureau of Mines (quality of scrap) and Department of Commerce (location and capacity) jointly.

b. Low-interest loans for automobile hulk flatteners and transport equipment.

c. Research and development.

d. National educational campaigns.

2. State share of gasoline tax would be applied in the following priorities.

a. Enactment of uniform titling legislation would speed title transfer, remove impound periods, remove notification procedures, and allow contract sale of low-value abandoned vehicles.

b. New registration procedures would be instituted to require proof of disposition of last vehicle.

c. Dismantlers, processors, insurance companies, and car dealers would be licensed for acceptable procedures and permitted to give proof of disposition.

d. Limited random-check procedures would be instituted on proof of disposition.

e. Needed forms for certifying disposition of automobiles would be made available.

f. Local government activities in cleaning up accumulated hulk problems would be supplemented.

II. Regulation

1. Model for State titling law.
2. Model licensing agreement for dismantlers, processors, etc.
3. Model proof of disposition certificate and registration modifications.
4. Renegotiation of ICC rail rates on scrap transport.
5. Accelerated depreciation for qualified shredders, etc.
6. Establishment of a commission to determine overall Federal policy, changes in gasoline tax, and other key factors regarding automobile recycling.

Minimize Environmental Damage

An enforceable provision (fine and imprisonment for perjury) on all future abandonments would be provided by ensuring adequate disposition of past vehicles at time of title application for next vehicle. The burden would be on the abandoners rather than on everyone. Inventories in dismantlers would also be reduced by encouraging lower transportation costs through loans for trucks and flatteners as well as for more shredders nearby. Educational campaigns would speed implementation.

Conserve Natural Resources

By lowering transport rates and encouraging higher quality scrap, scrap would be reused, and hence, natural resources would be conserved. Manufacturers would, moreover, be encouraged to aid recycling by changing composition and design. Research and development would improve future recycling.

Minimize Economic Disruption

Potential charges to automobile manufacturers would be small and deferred. Consumer/owner payments would also be small and spread over several years. The incentives to processors would be subject to qualification to prevent overcapacity in the industry.

Simplify Administrative Procedures

Channels already exist for the collection and distribution of funds. Licensing and forms design would require more administration but again channels exist. New legislation would be required, but this is a one-time effort. Enforcement of abandonment fines and titling, impounding, etc., would all be dramatically simplified.

STRATEGY E

I. Economic Incentives

I.A. *Revenue Sources*

1. A $10 deposit would be charged for each vehicle currently registered and $15 on each one manufactured or imported thereafter.

2. A reduction of $10 would be made on all newly manufactured vehicles that meet Bureau of Mines standards (to be set) on composition.

3. Fines of $10 per car would be levied on excess dismantlers' or processors' inventories.

I.B. *Revenue Uses*

1. Payment of $10 would be made to each processor/dismantler who accepts vehicles.

2. Low-interest loans would be made to qualified scrap processors as determined by Bureau of Mines (quality of scrap produced) and Department of Commerce (regional location and overcapacity considerations).

3. Excess would be directed to education and research.

II. Regulatory

1. Uniform titling would ease transfer of abandoned vehicles, with following added provision: a $500 penalty unless new vehicle registration were accompanied by proof of acceptable disposition of last vehicle by sale or delivery to dismantler or processor.

2. A $500 to $5,000 fine would be levied on any dismantler or processor who accepts a $10 payment but rejects any other vehicle delivered on which the title is presented.

3. A dismantler/processor inventory turnover tax would be based on inventory divided by vehicles received where tax is levied for all vehicles in inventory that exceed:

1.25 X received in 1971

1.00 X received in 1972

0.75 X received in 1973

0.50 X received thereafter.

4. An amendment to interstate commerce laws would prohibit rate setting that discriminates against secondary materials transport.

III. Education

1. Federal consumer education program on abandonment.
2. Training for scrap processors and dismantlers.

IV. Research and Development

1. Improved shredding.
2. Enclosed incineration.
3. Substitutes for copper.
4. Decreased transportation costs for automobile hulks.

Minimize Environmental Damage

The environmental insult caused by abandonment would be reduced by high fines levied on failure to show proof of acceptable disposition of the consumer's last vehicle and assurance that the fines could be easily enforced because the past owner would, in all probability, require another automobile. Moreover, each processor or dismantler would be paid to accept vehicles and fined heavily if he refused. Simultaneously, dismantlers' and processors' inventories would be reduced by regulated inventories.

Conserve Natural Resources

Low-interest loans would be provided to scrap processors to ensure high-quality scrap and its subsequent utilization by steel mills and foundries. Moreover, freight rates would further increase scrap's competitiveness with raw ore.

Minimize Economic Disruption

By minimizing the size of the charge to the consumer, his buying decisions would be minimally affected. Moreover, the staying of inventory reductions would limit the input on the dismantling industry and provide adequate time for it to adjust its operations. Furthermore, because most of this strategy would be accomplished through regulation with penalties for failure to obey, subsidies and their long-term effects would be minimized.

Minimize Administrative Procedures

A one-time charge on all vehicles with subsequent charges on new vehicles would aid in reducing administration of revenue collection. Moreover, determination of qualifications of scrap-processing facilities for low-interest loans would be accomplished by existing agencies. Enforcement of abandonment fines would be made routine, and no extensive search and notification procedures would be required.

STRATEGY F

I. Economic Incentives

I.A. *Revenue Sources*

1. A deposit of $50 would be required from each consumer on each vehicle registered the first year of the bill and on all vehicles manufactured or imported thereafter. A high-level appointed committee would regulate and update the bill.

2. A Treasury Department revolving fund would be set up to invest excess money and obtain interest from time lag between deposit and return.

3. A charge of $10 would be made to each manufacturer for each new car produced dropped to $5 per car if copper content were reduced below 0.1 percent of total weight by stripping of a simplified harness, which is possible through redesign. Bureau of Mines would administer.

I.B. *Revenue Uses*

1. A $50 deposit would be returned to last legal owner of any vehicle, including those in inventory on which no deposit has been collected--payments in excess would be limited to amount of interest.

2. Payments of sum to municipal governments if they have title.

3. Low-interest loans would be made to scrap processors for operations to produce high-quality scrap (administered by Bureau of Mines) in locations where overcapacity did not exist (administered by Department of Commerce).

4. Excess would be retained for inventory data network, educational programs, and research and development.

II. Regulation

1. ICC rail haul rates on scrap would be renegotiated to bring them in line with pelletized ore.

2. Tax laws would be changed to allow accelerated depreciation to scrap processors currently qualifying or about to qualify within 3 years (qualifications administered by Bureau of Mines).

3. A 1-year writeoff would be given for all screening costs for inventories.

4. A new eased titling law would facilitate transfer of title to municipality of abandoned vehicles.

III. Education

1. Federal consumer education program on abandonment.

2. Training for scrap processors and dismantlers.

IV. Research and Development

1. Improved shredding.

2. Enclosed incineration.

3. Substitutes for copper.

4. Decreased transportation costs for automobile hulks.

Minimize Environmental Damage

The strategy would reduce and should eliminate abandoned vehicles as an environmental blight by ensuring a positive value to the last legal owner of all obsolete and inoperable vehicles. The consumer would assume responsibility for recycle at the point of purchase and would be rewarded in the same amount for proper return of his discarded vehicle. Screening of inventories would at least shield dismantling and collecting facilities from public view.

Conserve Natural Resources

Manufacturers of new vehicles would be induced to share the burden of recycle and to consider design changes by paying a $10 maximum charge per vehicle. By carefully designing new vehicles and reducing difficult-to-recycle materials, manufacturers would be entitled to reduce their direct cost burden.

Minimize Economic Disruption

Although manufacturers would be charged a direct disposal cost, it is important that they too share the burden of improved environmental quality. Consumers would be refunded their initial deposit upon return of any registered inoperable vehicle. Processors would be invited to install more effective and improved processes, but their financial outlays would be offset by accelerated depreciation provisions and reduced freight rates.

Simplify Administrative Procedures

A new eased titling law would facilitate transfer of title to the municipality of abandoned vehicles and would reduce the administrative and legal difficulties of obtaining ownership of discarded vehicles. A special Treasury Department revolving fund would be set up to administer and allocate funds.

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