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Industry's Role in Conserving Material Resources

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INDUSTRY'S ROLE IN CONSERVING MATERIAL RESOURCES

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Those who produce the products that eventually become the waste stream are best equipped to cope with the problems created. -- Russell Train, Administrator, U.S. Environmental Protection Agency. (1)

Summary

Recycling is now recognized as the best solution for dealing with discarded products. But recycling is only a partial solution to the larger problem of conserving material resources. Moreover, most of the industries in the Rochester area are not the type that directly consumes scrap available from dealers; nor would these industries take reclaimed waste from the planned Monroe County resource recovery plant. *Source reduction*, a modification in the nature and use of manufactured products to reduce material consumption, is also necessary. Industry can plan a pivotal role both in furthering recycling and in helping to achieve source reduction through a variety of measures. These include (a)greater salvage of process wastes, (b)an increased use of recycled, instead of virgin, materials, (c)elimination of over-packaging and increased use of reusable containers, (d)greater product recyclability, (e)material substitutions, (f)scaling down product size, and (g)greater product durability.

The design of products which can perform the same function and are as durable as products which use more materials and energy presents a challenge to industry. An example of a local response to material conservation through scaling down is the development of the Xerox copier which can make copies on both sides of the paper. More compact housing is another example of scaling down.

Introduction

It is hard to determine whether some of the shortages of materials in recent years reflect actual scarcities, or merely the unwillingness or inability to pay higher prices. However, many observers feel that, if we have not already entered into an era of true material scarcities (especially of some minerals), this era is not far off.(2,3)

Perhaps the most quoted statement of statistics describing U.S. material consumption is, "The United States, with about 6% of the world's population, commands about 30% of the world's material consumption." (4) Another statistic, less quoted, is just as evocative. In 1950, the U.S. consumed about 26,000 pounds *per capita* of new minerals. In 1972, the figure had grown to 40,000 pounds per capita. (5) This enormous rate of consumption has raised the serious question of how long the U.S. can continue to exploit national and world resources as if their supply were inexhaustible.

As a direct result of the environmental movement, the energy crisis, and higher prices of materials, some progress is now being made toward achieving a more responsible use of resources and a reduction of waste. For example, the problem of solid waste disposal is no longer defined as simply how to get rid of waste as cheaply as possible. The problem is now seen as how best to recover and recycle useful materials or energy from the nation's trash. Efforts aimed at increasing the recovery and recycling of trash have taken two directions. The first is centered on individualized separation by households and businesses of paper, glass, cans, grease, and other waste components. The second is centered on the construction of large mechanized central resource recovery facilities. Monroe County's planned central resource recovery plant, which will combine salvage of metals and glass and a portion of the paper fiber, with the conversion of much of the organic waste into fuel, is a prototype of the second approach. It should be noted that the recovery or processing of trash in a central plant is a much more energy-demanding solution than separation at the source.

But even this new definition of waste management -- recycling instead of disposal -- offers only a partial solution to the much larger problem of achieving material conservation. A 1974 study by the U.S. Environmental Protection Agency concluded that full practical recovery of materials now discarded in the nation's trash would be equal to only a small part of annual U.S. material consumption. For example, full practical recovery of iron and steel from trash would yield an amount equal to 6.9% of U.S. consumption of iron and steel. Despite its abundance in the waste stream, the EPA concluded that full practical recovery of paper would produce an amount equal to 14% of consumption. These would represent net additions to the supply of secondary materials already supplied by existing recycling operations. (6) Secondary materials currently supply only 25% of U.S. raw materials needs for primary materials. Therefore, it appears from the EPA data that, if U.S. demand for raw materials remains at its current level, most of the nation's raw materials would still come from virgin sources. These data underscore the need to attack the problem of materials conservation through a variety of approaches in addition to recycling.

"Life Cycle" of Materials

The large volume of solid waste generated in the U.S. can be looked at as just one symptom of a larger problem: an imperfect, largely open-ended system for the extraction-production-consumption process. It is impossible really to understand, much less solve, the problem of waste without looking at the whole system. Only in this way is it possible to devise solutions that will not merely treat symptoms, but will attack the root cause. A new perception of materials is emerging, called the "life cycle" of materials, i.e., the process through which materials flow. A simplified diagram of the materials flow process is shown in Figure 1.

Source Reduction

In recent years, a new phrase has entered the vocabulary of solid waste management: source reduction. This term can be defined as a change or modification in the manufacture and use of products to reduce the amount of products that are discarded into the waste stream each year, reduce the amount of materials that ultimately must be discarded, and, in general, reduce the amount of raw materials consumed. The movement toward banning throwaway beverage containers is the prime example of efforts to date aimed at achieving source reduction. As a concept in the field of waste management, source reduction is a revolutionary idea. It is directed at changing the very nature of the materials flow stream, as opposed to handling waste simply "as is" and doing something with it. According to Russell Train, shifts in product design alone could help to reduce excessive use of certain materials by 20 to 25 percent.(1)

Industry's Role

To help focus on the pivotal role that industry could play in helping achieve material conservation through both recycling and source reduction, a discussion of some of the measures which could be taken follows.

Some, but not all, of the measures would obviously require major shifts in production and marketing patterns, and some would have to be accompanied by radical changes in consumer habits and life styles.

Salvage of process waste

The recovery of process waste and either its in-plant re-use or its sale to a scrap processor is an activity practiced by manufacturing firms. A national study made in the late sixties indicated that manufacturing industries salvaged substantial amounts of the waste they generated. Those surveyed, in the twenty manufacturing categories, had an average recovery rate of 46%, by weight, of the process waste they generated. (7) Raw materials shortages and price escalations have probably brought about higher recovery rates in cost-conscious industries.

Eastman Kodak is an example of a company that has developed a high degree of waste recovery and reutilization. Kodak not only salvages silver, plastics, paper and other materials, but also recovers waste heat from on-site electric power generation and from operations using process steam.

Although data are not available on the actual quantities of process waste that is recovered in the Rochester region, a recent study has concluded that "salvage of metals, oils, chemicals and paper is practiced to a great extent by local firms." On the other hand, this report noted that the portion of industrial waste "resembling ordinary household and commercial wastes" is discarded in private or municipal disposal sites. (8)

Further improvement in the salvage of industrially-generated waste is probably the most immediate step that industry can take in helping to conserve materials.

Use of recycled materials

There are about 190 million tons of major metals, paper, glass, rubber, and textiles used annually as raw materials by U.S. industry. Of this total, about 48 million tons, or 25%, is provided from recycling operations. The remaining 142 million tons come from virgin sources. (9,10) Most of the scrap, or secondary materials, used by industry consists of relatively pure, uncontaminated salvage from manufacturing operations, *not* from the post-consumer waste stream. Although the use of secondary materials has been historically declining as a proportion of total materials utilization, new products are now being developed, which are specifically aimed at tapping the resources available in the post-consumer waste stream. For example, the Glass Container Manufacturers Institute has sponsored research on the technology and economics of making a wide range of products from waste glass, such as a slurry seal, glass wool, terrazzo, foamed glass and ceramic tile. (11)

Historically, the nation's industries have been geared to using virgin sources as the main supply of raw materials, because of the need for a steady flow of huge amounts of materials which could not be supplied by secondary sources. Production modifications to allow a higher use of recycled materials would have to be matched by an increased flow of available secondary materials. As noted above, full practical recovery of materials in trash, added to existing supplies of secondary materials, would still fall far short of meeting the current U.S. demand for raw materials. Nevertheless, full practical recovery would contribute significantly to saving new materials. Efforts should be directed toward creating the industrial capability to absorb all the additional secondary materials that could become available both from an increased recycling of trash and a higher rate of recovery in industrial processing. Incentives proposed to help achieve an expanded recycling rate include tax credits, direct subsidies, accelerated depreciation for plant and equipment, more favorable freight rates for secondary materials, and an end to depletion allowances for virgin materials.

The nature of the local industrial make-up in any given area indicates both the opportunities and the limitations for direct action by local firms toward achieving a higher recycling rate. To give a background picture of the industrial base in the Rochester region, two tables are supplied in the Appendix. The major industries in the region are not the type that consume the reclaimed materials -- scrap iron, nonferrous metals, mixed glass, waste paper -- available from the traditional scrap dealer. Nor would these industries take materials which would become available from a Monroe County resource recovery plant. The region's manufacturing economy is dominated by the "instruments" manufacturing category, which included photo and optical manufacturing firms. This category accounts for 45% of the five-county region's employment, uses 34.3% of the materials consumed (by cost) and contributes 59% of the total value added by manufacturing. Typically, this category consumes finished parts and components or semi-finished products such as various mill shapes from the primary metals industry. (12) The photographic sector also consumes plastics, gelatin, and such chemicals as silver nitrate.

Large amounts of paper fiber are consumed locally for photographic paper and packaging, but the rigid specifications for both photographic paper and packaging virtually eliminate the use of reclaimed paper fiber from the solid waste stream. The use of waste glass for optical purposes has the same type of limitation. Recycled paper is produced for use in Xerox copiers. However, Xerox does not manufacture any of its paper products. These are all purchased by Xerox from other manufacturers. The second and third largest manufacturing categories, by employment, in the region are non-electric machinery and electric equipment. These industries are dependent mainly on semi-finished goods or finished components. On the other hand, the primary metals industry, the paper industry, and the glass industry, all of which directly consume secondary materials to a large extent, make up a substantially smaller proportion of the local manufacturing employment base compared to either state or federal ratios. As might be expected, the Hercules Market Analysis found only a few local manufacturing firms that would be likely purchasers of the reclaimed material to be provided by the Monroe County resource recovery plant. (13)

While only a relatively small number of local firms can work directly toward a greater use of recycled post-consumer waste in the products they produce, virtually all the firms in the area can carry out some of the other materials conservation measures that are described in this bulletin.

Packaging

Packaging material accounts for about 30 to 40 percent of municipal waste. Packaging utilizes about 47% of all paper production, 15% of aluminum production, 9% of the steel turned out, and 29% of plastic output. Packaging consumption has grown much faster than the materials being packaged. Measures leading toward a decrease in packaging consumption will require industry to make changes in three ways reviewed below. All three ways run counter to prevailing trends and practices. (14,15)

1. Size of containers According to the EPA, the trend toward small containers is costly in terms of resources used and waste generated. The elimination of all tomato juice cans less than 32 ounces, for example, would result in an estimated 20% reduction in steel consumed for this product. Therefore, one way to save resources would be to increase the average package size produced and consumed.

2. Overpackaging To eliminate overpackaging would mean a return to the old practice of using packaging to contain and protect a product; packaging aimed at advertising or displaying an item would be eliminated. Despite materials shortages and cost squeezes, the world-wide pattern is in the direction of expanding the use of packaging for advertising and display. However, a recent news story indicated cost consciousness about some modification, such as simplification and less use of color. (16) There are undoubtedly many ways in which excess packaging can be reduced without seriously affecting product marketability.

3. Reusable packaging Consumers throw away about 90% of all packaging material within a year of purchase. Refillable bottles and cartons make up a tiny portion of packaging, most of which is used only once. Most of the efforts to remedy this condition have focused on one type of packaging, the throwaway beverage container. The RCSI has issued two bulletins dealing with beverage container laws. (17,18)

Corrugated containers are usually used only once, but they have potential for reuse. There is a considerable amount of salvage and recycling of corrugated boxes into new products, as opposed to actual reuse. Local companies carrying on such activities include Loblaw, Neisner, Wegman and Hegedorn.

Product recyclability

Product recyclability refers to the relative technical ease with which it is possible to recycle a finished product after it has been used by the consumer. The EPA's *Second Report to Congress on Resource Recovery and Source Reduction* lists several ways in which product design might be altered to enhance the feasibility of recovering valuable materials from discarded products:

1. Improve identifiability of specific chemical compositions of complex products, i.e., through a "tracing" mechanism or material labeling.

2. Improve ease of mechanical disassembly of complex products, such as automobiles and appliances.

3. Standardize materials used in various products, e.g., the innumerable types of plastic used in various products.

4. Increase the chemical/physical separability of complex materials. (6)

Another aspect to product recyclability relates to how feasible it is to extract the materials in various products once they have become part of what is termed "mixed refuse." It is this type of mixed waste which will provide the main input for the Monroe County resource recovery plant. If large-scale mechanical recovery of urban refuse in central plants becomes widespread, then it will be important for industry to design its products so as to maximize the ease with which such products can be reclaimed in central recovery plants. Ease of recyclability would also, of course, help to achieve more household and business waste separation and recovery.

Materials substitutions

Substitution of one type of material for another is a process that goes on continuously in industrial production. Ideally, to conserve scarce resources, such substitutions should take the direction of (a)substitution of more-plentiful materials for less-plentiful ones, (b)substitution of materials which require less energy to extract and process, and (c)substitution of materials that can be cheaply recycled in terms of energy use and technology required, for materials that are costly or difficult to recycle.

In practice, determining what kind of substitutions to make often pose complex problems which can involve many trade-offs. For instance, the substitution of aluminum wiring for copper wiring conserves an element that is getting scarce, and can help to reduce product weight; however, aluminum wiring may not be as safe as copper. Another example of the need to look at trade-offs is the substitution of plastic components for metal components in cars. Plastic parts require a greater use of a petroleum-based materials in fabrication, but the car's weight is reduced, resulting in less petroleum being burned over the life of the car. On the other hand, most of the plastic parts in a car are not salvaged by auto wreckers, which means that there would be a larger amount of nonbiodegradable material (plastic) going to landfills.

According to the National Academy of Science, "Despite the complexity of the problem, an urgent need exists to include the assessment of alternative materials in the overall planning of industry and government." (19) The factors to be considered include strength, chemical and physical properties, availability, cost, consumer acceptance, and environmental impact.

During World War II, as noted by Victor Papanek, materials shortages forced designers who remained in the consumer field to a "much keener realization of performance of materials and other war-imposed limitations." (20) In future years, the same kind of awareness could help industry to bring about materials substitutions that could help to soften the impact of predicted future shortages. It has been predicted that the world's supply of silver will be exhausted by the end of this century. If this is accurate, then the substitution of alternative photographic processes not requiring silver will be required for Rochester's leading industry.

An example of a potential substitution that might have great impact is the use of sulphur as a substitute for traditional building materials such as concrete, steel, aluminum and bricks. This has been studied at McGill University. Sulfur is cheap, found throughout most of the world, and is easily recyclable without the use of expensive machinery (the energy required to liquefy sulfur is comparatively small in contrast to melting down steel). The group at McGill has developed interlocking sulfur building blocks and has fabricated furniture out of sulfur. In terms of bonding strength, impermeability to water and insulation value, sulfur appears to have excellent characteristics for construction. When mixed with sand or gravel, it has a compressive strength comparable to concrete. Its principal disadvantages are that it is difficult to cut and must be poured in a molten state. (21)

Scaling Down

The sharp rise in the cost of most forms of energy has already had a dramatic impact on the size of several consumer products, most notably the car. With fuel economy and operating costs now playing a decisive role in consumer demand, the weight of the average car manufactured in the U.S. is going down, since weight and fuel consumption are so closely related.

But it is not only the size and weight of cars that is being pressured downward by the dual, inter-related factors of high energy costs and high materials costs. Trends toward smaller single-family homes and more compact suburban development also reflect energy-materials cost considerations, although there are other factors involved, such as smaller average household size.

Energy costs and availability have an impact on material utilization throughout the entire material life cycle. The net result of energy shortages will probably be a scaling down of materials in most products. It should be noted that some energy conservation measures can result in a greater quantity of materials utilization, as for example in the provision of more insulation in a building. This increased material use could be offset if there is also a material savings achieved through a smaller heating or cooling system that can serve a better-insulated building. It should also be pointed out that if scaling down takes the shape of reducing product durability or recyclability, it could be wasteful in the long run.

Modern technology is replete with examples of changes which have brought about a scaling down in product size, although neither energy nor material conservation may have been a major motivation in bringing about such changes. Today's featherweight transistor hand calculator can do the same work -- or more -- as can a mechanical calculator weighing several pounds. Duplicating machines, such as those produced by Xerox, which can make copies on both sides of a sheet of paper, represent another form of product scaling down (from one-sided copying) which saves on materials.

The design of products which conserve materials and energy (while performing the same functions and having the same durability as products which use more materials and energy) presents a challenge to producers of goods both in the U.S. and throughout the world.

<u>Durability</u>

The duration of the use of manufactured products is a key variable in the process determining how much material is used and how much is discarded. However, product lifetime, or durability, is not merely a function of the quality built into the product by the manufacturer. Conditions of use, intensity of use, and degree of maintenance are also critical factors.

Victor Papanek has attempted to estimate the "primary useful life" of various products, and to compare this against the "actual time used" in the U.S. versus the "actual time used" in underdeveloped countries. He found that the actual time used in the U.S. was much less than hypothetical useful life for most products, whereas in underdeveloped countries most products appear to be used longer than their presumed useful life. (20) This phenomenon appears to have little to do with the actual "durability" of a product, but with the fact that consumers in rich countries can afford to throw away products which still have a long, useful life, whereas in poor countries they cannot.

Plentiful cheap energy and cheap material resources permitted the development of an economic system in which "planned obsolescence" has governed the production of many types of goods.

Materials shortages, and the economic squeeze affecting many consumers, may work to bring about changes in America's throwaway economy, and create demand for goods that are designed to last longer. If Stuart Udall is correct, such a change would simply mean a return to a former way of producing goods:

> *Fifty years ago, durability was the sine qua non of U.S. manufacturing. Razors, watches, clocks and many other products were literally made to "last a lifetime." In those days, frugal people wanted long-lived machines and products which were simple enough that they could be maintained in good operating conditions. Inventors and engineers put durability first in their designs, and everything from the Model-A Ford to household appliances exemplified a commitment by manufacturers to the production of serviceable, long-lasting goods.* (22)

The design of longer lasting products poses another challenge to engineers and production experts. But increasing the useful life of products also presents a challenge to consumers, and an economic system in which the throwaway lifestyle has flourished.

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APPENDIX

Table 1. Manufacturing Employment: Percentage Distribution by Industry

Industry	Rochester S.M.S.A. (%)	New York State (%)	U.S. (%)
Instruments, including photo and optical	44.9	5.9	2.1
Machinery except electrical	10.7	8.9	10.0
Electrical and Electronic equipment	9.1	10.9	9.5
Food	6.8	6.4	9.0
Fabricated metals	5.5	5.3	7.3
Printing	5.2	11.3	6.0
Apparel	3.3	16.3	7.5
Paper and allied products	2.3	3.6	3.6
Rubber, plastics	2.3	2.0	3.1
Stone, clay, glass	1.7	2.4	3.3
Chemicals	1.6	3.7	4.9
Primary metals	0.9	3.9	6.7
Other manufacturing	5.7	19.4	27.0
Total percent	100.0	100.0	100.0
Total Employment (Thousands)	130.2	1540.5	17426.3

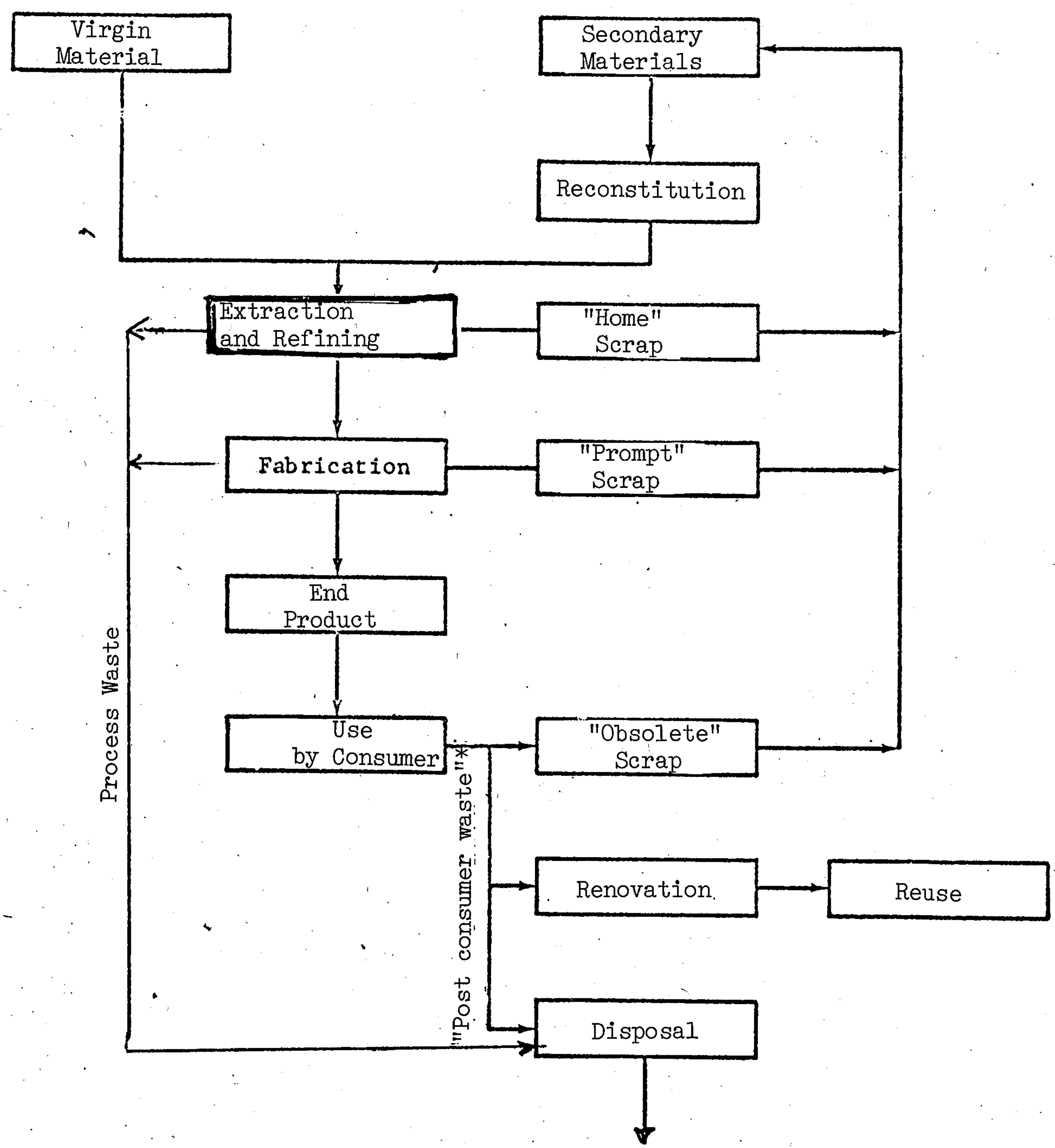
Notes and Sources: The Rochester Standard Metropolitan Statistical Area (S.M.S.A.) consists of Livingston, Monroe, Ontario, Orleans and Wayne Counties. Employment totals are for operating manufacturing plants and exclude data for central administrative offices. Data for New York State and for U.S. is from 1971 Annual Survey of Manufactures. Data for Rochester S.M.S.A. is from 1972 Census of Manufactures, except for instrument (SIC CODE 38) which is from 1971 Survey of Manufactures, 1972 Census of Manufactures did not break out data for SIC CODE 38 for Rochester S.M.S.A. because of possible disclosure.

Table 2. Cost of Materials and Value Added by Manufacturing, Rochester S.M.S.A.

Industry	Cost of Materials: Millions of dollars	Cost of Materials: %	Value Added by Manufacturing: Millions of dollars	Value Added by Manufacturing: %
Instruments, including photo and optical	602.0	34.3	2,598.5	59.3
Food	328.7	18.7	263.2	6.0
Machinery except electrical	151.2	8.6	312.0	7.1
Electrical & Electronic equipment	130.4	7.4	232.6	5.3
Fabricated metals	107.3	6.1	144.9	3.3
Paper and allied products	55.1	3.1	57.2	1.3
Printing	53.0	3.0	127.7	2.9
Chemicals	45.1	2.6	76.2	1.8
Apparel	34.4	2.0	53.1	1.2
Rubber, plastics	26.0	1.5	49.3	1.1
Stone, clay, glass	24.7	1.4	42.2	1.0
Primary metals	18.5	1.1	16.6	0.4
Other manufacturing	180.7	10.2	409.3	9.3
Total	1,757.1	100.0%	4,382.8	100.0%

Notes and Sources: The Rochester Standard Metropolitan Statistical Area consists of Livingston, Monroe, Ontario, Orleans and Wayne Counties. Cost of materials includes all raw materials, semi-finished goods, parts components, containers, scrap and cost of fuels and purchased electricity. Data is from 1972 Census of Manufactures, except for instruments (SCI CODE 38), which is from 1971 Survey of Manufactures. 1972 Census of Manufactures did not break out data for SIC CODE 38 for Rochester S.M.S.A. because of possible disclosure.

Figure 1 MATERIALS FLOW CHART



*"Post consumer waste" = refuse, garvage, junk, discarded products

(Chart adapted from illustration prepared by Camp, Dresser, McKee, engineers.