Profiles of Major Suppliers to the Automotive Industry
Volume I: Overview

J.A. Mateyka
W.R. Magro
A.S. Karlin
D.J. Yee

Booz, Allen and Hamilton, Inc.
Transportation Consulting Division
Bethesda MD 20014

August 1982
Final Report

U.S. Department of Transportation
National Highway Traffic Safety Administration

Office of Research and Development
Washington DC 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-HS-806 216		

4. Title and Subtitle	5. Report Date
PROFILES OF MAJOR SUPPLIERS TO THE AUTOMOTIVE INDUSTRY: VOLUME 1 OVERVIEW	August 1982
	6. Performing Organization Code: DTS-322
7. Author(s) J.A. Mateyka, W.R. Magro, A.S. Karlin, D.J. Yee	8. Performing Organization Report No.: DOT-TSC-NHTSA-82-1.I
9. Performing Organization Name and Address: Booz, Allen and Hamilton, Inc.* Transportation Consulting Division Bethesda, Maryland 20014	10. Work Unit No. (TRAIS): HS275/R2412
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: U.S. Department of Transportation National Highway Traffic Safety Administration Office of Research and Development Washington DC 20590	13. Type of Report and Period Covered: October 1978-October 1980 Final Report
	14. Sponsoring Agency Code: NRD-13

15. Supplementary Notes

*Under contract to: U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge MA 02142

16. Abstract

This study summarizes extensive information collected over a two-year period (October 1978 to October 1980) on suppliers of parts and components, materials, and machine tools to the automotive industry in the United States. The objective of the study was to provide data and information in support of analyses of the U.S. automotive industry. The results of this effort are published in seven volumes --- Volume I: Overview; Volume II: Iron, Steel, and Aluminum Suppliers to the Automotive Industry; Volume III: Plastics, Glass, and Fiberglass Suppliers to the Automotive Industry; Volume IV: North American Parts and Component Suppliers to the Automotive Industry; Volume V: Multinational Automotive Parts and Components Suppliers; Volume VI: Foreign Automotive Parts and Components Suppliers; and Volume VII: Machine Tool Suppliers to the Automotive Industry.

17. Key Words	18. Distribution Statement
Automotive Parts, Components, Materials; Plastics, Class, Fiberglass; Machine Tools	DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	168	

PREFACE

Automobile manufacturers, in general, produce only selected, key elements and subassemblies for their final product, and rely on a widespread and complex logistics network including material suppliers, foundries and fabricators for wide variety of other necessary components going into the finished automobile.

Because of the importance of the automobile industry to the United States and to the world economy, it is important to understand the makeup of the logistics infrastructure and to understand its internal interrelationships and workings with the industry it supports.

The purpose of this study was to gather all possible and pertinent information on suppliers to the automotive industry, and to present it in a form for ease of reference and further analysis.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

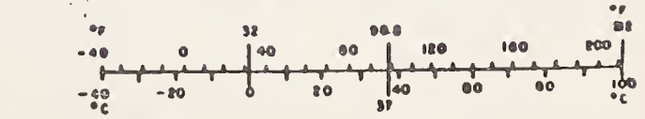


TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES (Continued)

1. INTRODUCTION

This final report summarizes extensive information collected over a two-year period (October 1978 to October 1980) on suppliers of parts and components, materials, and machine tools to the automotive industry in the U.S. The information collected was restricted to that which was publicly available and was provided to the U.S. Department of Transportation's Transportation Systems Center (DOT/TSC) in a series of prior reports on various groups of supplier industries and profiles of major supplier companies.

The objective of the contract was to provide the U.S. Government's automotive industry analysts and decision makers with the information necessary to evaluate the impact that government regulations and the market-driven rapid redesign of U.S. automobiles was having on the automotive supplier industry. The focus was on current information about the "independent" supplier industry. Because automotive mass production is carried out in the U.S. by large, vertically integrated primary manufacturers which make many of their required components and parts, independent suppliers are important for certain components, but not for others as shown in Figure 1-1. The focus of this effort was to collect information about supplier activities, which fall to the left of center in the figure. Figure 1-1 approximates the split of economic activity for domestically produced automobiles. The bars would shift for any specific vehicle manufacturer or any specific make/model automobile. Detailed information about the components and parts produced by vehicle manufacturers was not collected under this contract, with a few minor exceptions.

The independent automotive supplier industry was split into a number of industry groups, and summary information concerning each group's structure, sales, employment, operations, and financial condition was collected with an emphasis on the automotive supply aspects of a group.

Then major companies were selected within each group and company profiles were developed. These profiles related an overview of the company's size, structure, revenues, and

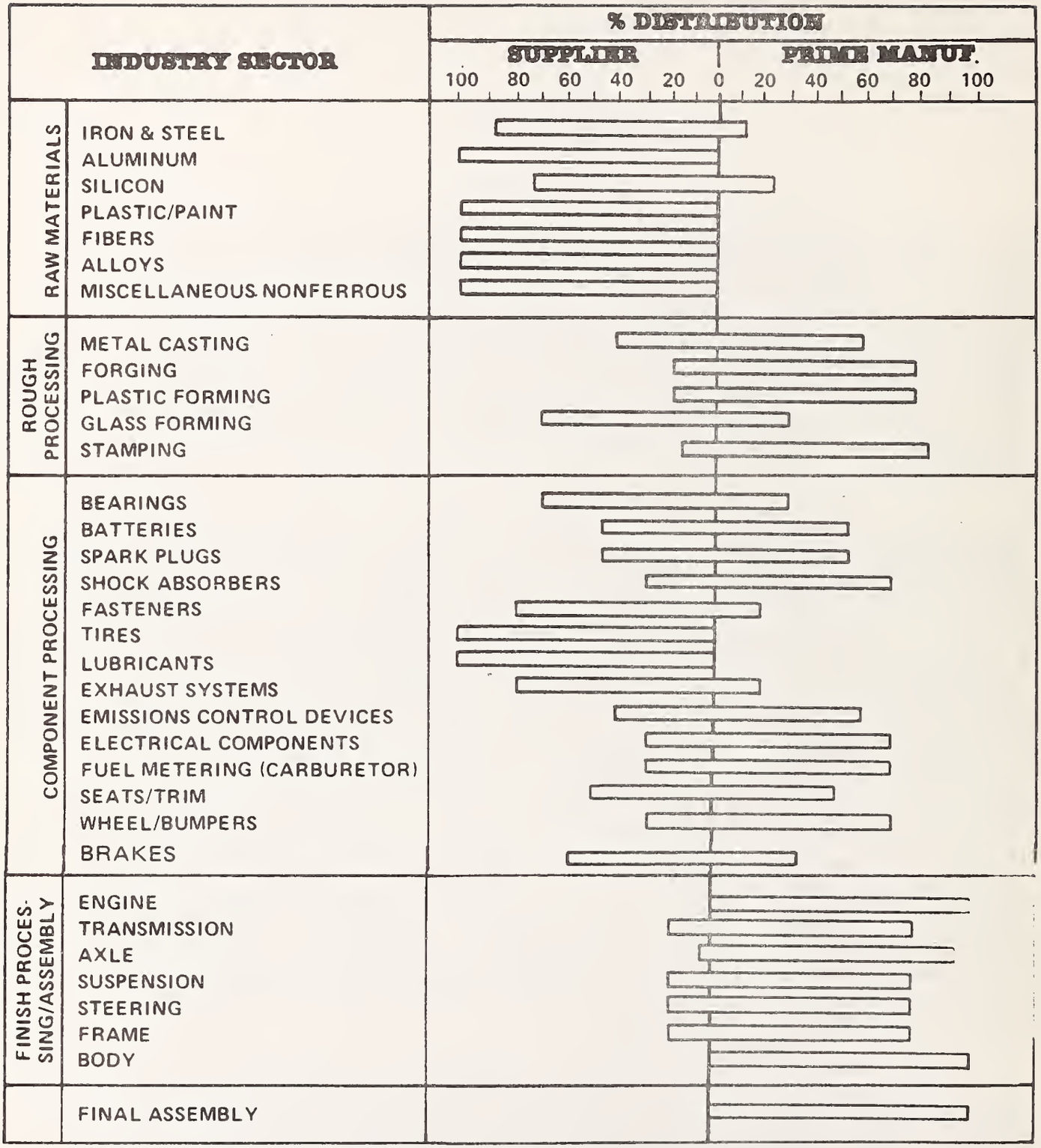


FIGURE 1-1. STRUCTURE OF TYPICAL SUPPLIER/MANUFACTURER ACTIVITY IN THE PRODUCTION OF A DOMESTIC AUTOMOBILE

employment. The profiles also contained information about the company's products and markets, with specific emphasis on automotive-related activities. Detailed information on automotive-related production and operations was collected including the location, products, and employment of specific plants, as well as planned plant expansions or closings. The financial status of the company was profiled for the most recent three to five years. Announced R&D activities and expenditures were documented. Finally, each company profile included a discussion of important aspects of the company's recent labor and government relations.

Table 1-1 lists the supplier industry groups and the specific companies for which profiles were prepared. This is not a comprehensive list of major suppliers. Companies were picked for profiles if they had major automotive original equipment market positions and/or were a major manufacturer of a specific component of interest. Thus many major suppliers of primarily heavy-duty vehicle components or primarily aftermarket suppliers do not appear. Typically larger publicly-held companies were chosen since more publicly available information was available. The focus was on suppliers for U.S. automobiles, thus the only foreign suppliers chosen were those major suppliers which had or planned to have a significant position in supplying U.S. auto manufacturers. For this reason, Japanese suppliers do not appear.

Over the two-year period, approximately 4,000 reference documents were collected and employed to prepare company profiles and industry group overviews. The publicly available information sources that were typically employed included: trade journal and technical articles/papers; company annual reports and 10K reports; security analysts' reports; company marketing, product, or advertising literature; speeches at annual meetings; speeches before the New York Society of Security Analysts; plant guidebooks and other information clearly in the public domain. In very rare cases, primarily in the collection of information on foreign companies, were visits made to interview company officials. This was accomplished by the Economist Intelligence Unit (EIU), a subcontractor in London.

Individual companies and industry associations were generally very cooperative in supplying publicly available information upon request via telephone. Information on specific plant locations and employment was generally gathered in this fashion.

TABLE 1-1. SUPPLIER INDUSTRY GROUPS/COMPANIES PROFILED

- North American Parts and Components Suppliers
  - A.O. Smith
  - Arvin
  - Champion
  - Colt (Holley)
  - Dana
  - Delco Remy
  - Eaton
  - Fruehauf
  - Gould
  - Motorola
  - Sheller Globe
  - Tenneco
  - Timken
- Multinational Parts and Components Suppliers
  - Bendix
  - Borg-Warner
  - Budd (Thyssen A.G.)
  - Goodyear
  - ITT
  - TRW
- Foreign Parts and Components Suppliers
  - Bosch
  - Dunlop
  - Michelin
  - GKN
  - Valeo
  - Lucas
- Machine Tool Suppliers
  - Acme Cleveland
  - Cincinnati Milacron
  - Cross and Trecker
  - Giddings and Lewis
  - Lamb
  - Motch and Merryweather
- Steel
  - U.S. Steel
  - Bethlehem
  - LTV
  - ARMCO
  - National Steel
  - Republic
  - Inland
- Aluminum
  - Alcoa
  - Alcan
  - Reynolds Metals
  - Kaiser Aluminum
  - Alumax
- Castings
  - Hayes-Albion
  - Dayton Malleable
  - Lynchburg
  - CWC-Textron
  - Doehler-Jarvis
  - Wheland Foundry
  - Automotive Specialties
  - Columbus Foundries
- Plastics
  - Monsanto
  - Borg-Warner
  - Union Carbide
  - Mobay
  - Hercules
  - Amoco
  - B.F. Goodrich
  - DuPont
  - General Electric
  - General Tire
  - Davidson
- Glass and Fiberglass
  - PPG
  - Libbey-Owens-Ford
  - Owens-Corning

Because this effort spanned a period (1979 and 1980) of great change in the U.S. automobile industry, information originally supplied to profile industry groups/specific companies was updated monthly via supplemental information supplied to DOT/TSC. The series of reports supplied with updates thus became draft working papers for DOT/TSC and remained as current as the source material collection system allowed.

As the prime contractor, Booz, Allen & Hamilton had final responsibility for all report preparation. The Chilton Company, a subcontractor, provided services in information collection and the professional expertise of editorial staff personnel familiar with various supplier industry groups. The Motor and Equipment Manufacturers Association (MEMA), a subcontractor, provided public information on various suppliers and specific information on the issues of greatest importance to various supplier industry groups. As mentioned previously, EIU provided information on certain foreign and multinational suppliers as did the European offices of Booz, Allen & Hamilton's Worldwide Automotive Consulting Practice.

This contract did not require the detailed analysis of information gathered to predict trends or analyses of the future viability of various companies, markets, product lines, etc. This document is a highly distilled summary of information gathered during this massive two-year effort. It summarizes and supplements materials provided to DOT/TSC in the following reports:

- North American Automotive Parts and Components Suppliers
- Multinational Automotive Parts and Components Suppliers
- Foreign Automotive Parts and Components Suppliers
- Machine Tool Suppliers to the Automotive Industry
- Iron, Steel and Aluminum Suppliers to the Automotive Industry
- Plastics, Glass and Fiberglass Suppliers to the Automotive Industry.

2. PARTS AND COMPONENTS SUPPLIERS

This chapter profiles the automotive parts and component supplier industry and companies within this industry. The chapter begins with an overview of the industry, followed by a discussion of the industry's products, markets, and major trends. Profiles of individual companies are provided at the end of this chapter.

2.1 INDUSTRY OVERVIEW

The automotive parts and components industry is one of the Western World's largest industries. There are about 30 to 40 major (sales of more than $0.5 billion/year) component suppliers with combined sales of over $50 billion/year. In addition, there are seven major tire suppliers in the "Atlantic Market," with combined sales exceeding $23 billion/year.* To this is added hundreds of medium-size suppliers and thousands of small supplier firms.

A key feature of automotive manufacturing, and in particular, parts and components manufacturing, is its labor intensiveness. In many countries in the Atlantic Market, as much as 5 to 8 percent of manufacturing employment is provided by the automotive industry. According to the United States Census of Manufacturers in 1976, while 324,300 people were employed in motor vehicle manufacturing, 889,200 people were employed in automotive parts and components industries, including tires and metal stampings. Automotive-related employment increases substantially when employment in the various industries related to automotive service and other automotive-related transportation infrastructure functions (fuel, road maintenance, etc.) are added. In the Atlantic Market, national governments are becoming increasingly sensitive to the health of their auto industries due in part to employment issues.

It is becoming increasingly difficult as the motor vehicle industry becomes a world industry to neatly categorize automotive supplier firms. It is also increasingly difficult to track shipments of parts and components within the

---

* Includes sales of all goods and services, not just automobile-related products.

worldwide network that is developing to support the so-called "world cars" of various major automotive manufacturers. In 1976, the U.S. imported about $3.7 billion worth of motor vehicle parts and accessories, as compared to $53.6 billion (value of shipments) of the domestic automotive parts and components industry. With the rapid shift in vehicle designs in the U.S. to small fuel-efficient vehicles, this pattern may be changing.

For purposes of this report the automotive parts and components industry in the Atlantic Market has been divided into two groups as follows:

- North American and U.S.-based Multinational Parts and Components Suppliers
- Foreign Suppliers.

2.1.1 North American and U.S.-Based Multinational Parts and Components Suppliers

This group of suppliers consists of U.S.-based companies serving the domestic and/or foreign market. It consists of a large number of companies that vary in size and product. The various studies that have attempted to profile the independent automotive parts and components manufacturers as a group often employ different groupings/definitions because of the fragmented and diversified nature of the "parts and components" industry. Business Week* estimates that approximately 2,000 suppliers sell $40 billion worth of parts to the U.S. auto industry each year. Iron Age** estimates that this is about two-thirds of the sales of companies labeled as auto suppliers. Standard and Poor's*** estimates that total employment of independent suppliers is in excess of 400,000 people. Many of the companies that supply the auto industry are quite small; only about 900 companies employ 20 or more workers. It is estimated that the top 20 companies supply more than 25 percent of the market.

---

* "Detroit's New Face Toward its Suppliers," Business Week, September 24, 1979, p. 140.

** "No Dramatic Change Seen by Auto Suppliers," Iron Age, December 3, 1979.

*** Standard and Poor's Auto Industry Analysis, October 1978.

The U.S.-based multinational parts and components suppliers are defined as those American-based companies with significant operations both in the United States and overseas. These companies in general participate in the same market environment as the North American suppliers, but sell to a greater extent in the world car market. As a result, these companies are in an excellent position to transfer technology to various parts of the world.

Table 2-1 lists the major North American and U.S.-based multinational parts and components suppliers to the auto industry. Companies selected for analysis in the reports are identified with a dot in the table. They were chosen to represent a broad range of products with a preference given to companies with relatively large OEM sales. One-page profiles for each selected company, summarizing readily available information, are provided at the end of this chapter.

2.1.2 Foreign Parts and Component Suppliers

Compared to data on North American-based companies, detailed information about automotive component suppliers in Europe is less available in the public literature. Therefore, the focus of this report has been on the largest European-based suppliers with a multinational focus. The top five companies that supply parts and components in Europe have annual combined sales in excess of $15 billion (excluding tires). Two European-based tire companies dominate that industry in Europe. Below these major component suppliers, there exist 10 to 15 companies with annual sales of $500 million or more.

Each of the major European countries has one or two very large component suppliers. These large companies have strong domestic markets, but unlike many U.S. suppliers, have substantial markets in nearby countries in Europe and the rest of the world. While it is difficult to generalize about products of these very large European component manufacturers, there is a clear orientation toward high-technology fuel and electrical system components.

A pattern of partial joint ownership of smaller European components suppliers by the very large suppliers appears to be emerging, but this is often an issue with the various national governments in Europe. The complexity of joint ownership, joint ventures, and other related activities among suppliers and vehicle manufacturers in Europe is substantial.

TABLE 2-1. MAJOR NORTH AMERICAN AND U.S.-BASED MULTINATIONAL PARTS AND COMPONENTS SUPPLIERS

Supplier	Estimated Sales to Auto Industry, 1979* $ Millions	Total Sales 1979 $ Millions	Major Products	Estimated Portion of Sales to OEM**
Bendix●	$1,953	$3,829	Brakes, steering systems, fuel systems	Medium
Rockwell	1,853	6,176	Plastic parts, electronics and truck parts	High
TRW●	1,778	4,560	Chassis, engine and steering system components	Medium
ITT●	1,720	17,197	Disc brakes, McPherson struts	Medium
Eaton●	1,646	3,360	Valves, springs, emission control systems	High
Dana●	1,574	2,761	Frames, clutches, pistons	High
Borg-Warner●	1,168	2,717	Rear axle assemblies, manual transmissions	High
Budd●	963***	1,284	Frames, hoods, fenders	High
Tenneco●	785	11,209	Exhaust systems, shock absorbers, emission controls	Low
Fruehauf●	784	2,451	Brakes, wheels, valves	Medium
Champion Spark●	597	807	Spark plugs, wipers	Low
Federal Mogul	557	663	Bearings, engine products	Medium
Colt●	535	2,141	Carburetors, intake manifolds, fuel pumps	High
Sheller-Globe●	499	656	Hoods, fenders	High
Gould●	486	2,024	Batteries	Medium
Arvin●	325	493	Mufflers, catalytic converters	Medium
A.O. Smith●	443	836	Frames, structural parts	High
Maremont	324	338	Shock absorbers	Low
Timken●	321	1,282	Roller bearings	High
Armstrong Rubber	303	394	Tires	Low
McGraw-Edison (Wagner)	280	1,331	Brakes	Medium
Motorola●	190	2,713	Radios, electronic controls	Medium
Houdaille	81***	350	Bumpers	High
Irvin	80***	64	Seat belts	High
Goodyear●	Not Available	8,239	Tires	Medium
Signal Co. (Garrett)	Not Available	4,241	Turbochargers	High
Firestone	Not Available	3,284	Tires	Medium
B.F. Goodrich	Not Available	2,988	Tires	Medium
Uniroyal	Not Available	2,575	Tires	Medium
General Tire	Not Available	2,295	Tires	Medium
AMP	Not Available	1,013	Electrical components	--
National Semiconductor	Not Available	720	Semiconductors	High
Intel	Not Available	663	Electrical components	High
Hoover Universal	Not Available	601	Aluminum and plastic products	--
Stewart-Warner	Not Available	366	Gauges, speedometers	High
Belden	Not Available	291	Electrical components	Low
Simpson	Not Available	124	Machined parts	High
Delco Remy●	Not Available	Not Available	Electrical components	High

* Includes autos, trucks, OEM and aftermarket
** Low implies less than 30%, Medium: 30-70%, High: More than 70%
*** 1977 data
● Companies covered

Because of growing saturation of some European markets and declines in domestic vehicle production in some countries, European component suppliers have begun to view the U.S. market and its needs for high-technology, downsized components as very attractive. Current sales to U.S. vehicle manufacturers are relatively small. However, as is clear from the profiles of the large European-based component suppliers contained at the end of this chapter, substantial strategic activities in product research, development, and even new U.S. plant construction is underway. The focus, again, is on high-technology, hence high-margin products. The plant investment appears to be occurring disproportionately in the southeastern states.

Table 2-2 lists the major foreign component suppliers to the auto industry. The companies selected for analysis in this report are identified with a dot in the table. These manufacturers were chosen because they were important in the Atlantic Market and/or they had product technologies liekly to be important in the U.S. in the next few years. Summary profiles of these companies are contained at the end of this chapter.

2.2 PRODUCTS

While most companies manufacture many different parts, each is still usually identified with one or two primary products. Various industry products are listed below along with major companies in each segment.

- Frames. The largest U.S. manufacturer of frames is A.O. Smith Corporation. Other companies in the field include Dana Corporation, Budd Company (Thyssen A.G.), and Midland Steel Products.

- Wheels and Tires. The largest U.S. producer of wheels is Kelsey-Hayes (part of Fruehauf Corporation). Other companies include Motor Wheel (part of Goodyear) and Budd Company. Major tire manufacturers include Goodyear, Firestone, Uniroyal, General Tire, Michelin and Dunlop.

- Brakes. Major brake producers include Kelsey-Hayes, Goodyear, Budd Company, Bendix, Delco Products (General Motors), Lear Siegler and Raybestos Manhattan.

- Ball and Roller Bearings. The automotive industry is the largest user of bearings. According to

TABLE 2-2. MAJOR FOREIGN COMPONENT SUPPLIERS

Company	Location	1979 Revenue ($ Billions)
Michelin●	France	6.24
Dunlop Pirelli Union●	Britain-Italy	5.98
Robert Bosch●	Germany	5.90
Guest, Keen and Nettlefolds●	Britain	4.16
Bridgestone Tire	Japan	2.66
Lucas Industries●	Britain	2.18
Ferodo Groupe●	France	1.43
Continental Gummi Werke	Germany	1.43
Zahnradfabrik Friedrichshafen	Germany	1.11
Yokohama Rubber	Japan	1.00
Usines Chausson	France	.96
Ausin Seki	Japan	.87
Kanto Auto Works	Japan	.86
Associated Engineering	Britain	.76
Dunlop Australia	Australia	.72

● Companies covered in this report.

Standard and Poor's Industry Surveys, eight producers of bearings probably account for 90 percent or more of the industry total. These are Timken Company, General Motors, Textron, SKF, Federal Mogul, TRW, Gulf and Western, and Federal Bearings.

- Batteries. Delco Remy Division of General Motors is the largest producer of automotive batteries and is a major producer of maintenance-free batteries. Other battery producers are ESB (part of Inco Ltd.), Globe-Union, Gould, General Battery (Northwest Industries) and Eltra Corporation.

- Exhaust Systems. The exhaust system market includes mufflers, catalytic converters and connecting pipes. Major manufacturers include Arvin Industries and Walker (part of Tenneco).

- Carburetors. Major carburetor producers are Holley (Colt Industries) and Carter.

- Engines, Transmissions and Drivetrain Parts. This segment includes valves, springs, pistons, piston rings, axle assemblies, etc. Major companies in this area include Eaton, Dana, TRW, Borg-Warner, Sealed Power, Bendix, GKN and Ferodo.

- Shock Absorbers. This segment also includes producers of the MacPherson struts, usually used in smaller cars. Major companies include Monroe (part of Tenneco), Delco Products (part of GM), and Maremont Corporation.

- Electrical Parts. Manufacturers of ignition systems include Delco Remy (General Motors), Echlin, Prestolite (part of Eltra), Robert Bosch, and Lucas. Major producers of auto radios are Delco Remy and Motorola. Producers of automotive electronic components include Bendix, Motorola and Delco electronics (General Motors).

The realities of North American motor vehicle manufacturing are such that vertical integration of parts/components activities with final vehicle manufacturing within a given vehicle manufacturer is much more common for automobile production (and light-duty truck) than for heavy-duty vehicle manufacturing. Thus, independent suppliers tend to have a relatively higher level of activity in heavy-duty vehicle components.

2.3 MARKETS

Parts and components suppliers have three separate types of markets for their products as follows:

- Original Equipment Market (OEM): Automotive products sold directly to vehicle manufacturers as parts for new vehicles
- Aftermarket: Automotive products sold through a complex distribution system that are used to maintain/repair vehicles-in-use
- Non-Automotive: Products related to automotive which are sold to a host of other industries, i.e, marine, aerospace, communications, energy industries, etc.

Most larger suppliers, and even many smaller suppliers, participate in all three markets. Strategic business decisions for parts and components suppliers are often related to balancing their market and product development activities among the three markets. The relatively large capital investments required for mass production of parts and components and the inherent nature of many of the product lines limits the flexibility of many suppliers to respond rapidly to shifts in markets and product technology.

2.3.1 Original Equipment Market (OEM)

The original equipment market contains a small central group of large industrial customers. The market is characterized by extreme competition, high quality and production standards, and tight profit margins. In addition, sales volumes are very cyclical, since they are tied to motor vehicle sales, which in turn are highly sensitive to North American business cycles.

Marketing to the OEM manufacturers is very different from selling to the aftermarket. Suppliers must maintain contacts with a number of different departments of the major auto producers, such as engineering, manufacturing, service and purchasing, working closely with the auto manufacturers to develop new components. Once specifications for components are established, the auto manufacturers can ask for competitive bids, and companies that participated in the product development may have a considerable advantage due to their expertise. Most contracts are for the model year with some flexibility of volume depending on auto sales. However, sometimes auto manufacturers will favor companies that helped with development and award them long-term contracts.

In addition to the risks of the business cycle, the OEM market is highly sensitive to vehicle manufacturers' make/buy decisions for many parts and components; i.e., the large vehicle manufacturer can decide to make the particular component in its own facilities. For obvious reasons, vehicle manufacturers always attempt to maintain multiple sources of supply for critical components. In times of expanding vehicle production and little fundamental change in component technology, price competition among suppliers will be intense. Suppliers, however, must generally maintain a position in the OEM market to sell in volume to the aftermarket.

Companies often considered original equipment suppliers are those manufacturing wheels, frames, axles, bearings, valves, brakes, bumpers, carburetors and padding. Such companies include Bendix, Dana, Eaton, TRW, Timken, Kelsey-Hayes and Sheller Globe. OEM parts are generally long-life parts, a high percentage of which are expected to last the life of the vehicle in service.

2.3.2 Aftermarket

Unlike the original equipment market the aftermarket is a more stable source of component sales volume. While aftermarket sales are influenced by a number of factors, this market is often viewed as counter-cyclical for some products; i.e., during economic downturns motorists keep their cars longer and require more replacement (aftermarket) parts. Many suppliers view a strong position in the aftermarket as a stabilizing influence on company revenues.

Selling to the aftermarket requires expertise in advertising and distribution. Aftermarket suppliers advertise to both the consumer and the retailer and also sponsor special promotional discounts and contests. Sales are generally made to jobbers and retailers, and product availability and speed of delivery are important in making sales.

As North American motorists exhibit a trend toward longer average vehicle life, many forecasters have predicted strong long-term growth in the aftermarket. This has encouraged some suppliers to increase their aftermarket participation. A few large companies have even forwardly integrated into ventures in automotive repair and service activities.

Companies that make spark plugs, batteries, mufflers, shock absorbers and filters, are often considered aftermarket companies. Examples of these companies are Echlin

Manufacturing, Genuine Parts, Monroe Auto Equipment and Champion Spark Plug. Many of these companies are also very important original equipment suppliers. However, the aftermarket is much larger than the original equipment market for their products, which are typically "high turnover" maintenance and service items that must be replaced a number of times in the life of an automobile.

2.3.4 Non-Automotive

Most companies labeled automotive parts and components suppliers, especially the larger companies, have a diversified range of products. These product lines may be spinoffs of automotive technologies, acquisitions of technologies/products that enhance their automotive-related business or even totally separate unrelated product lines or business ventures.

When business difficulties are encountered in the basic automotive supplier activities, some companies respond by attempting to diversify. Such strategic decisions will vary widely as the summary profiles of the North American parts and components manufacturers at the end of this chapter will clearly indicate.

2.4 MAJOR TRENDS AFFECTING THE INDUSTRY

This is clearly a period of fundamental structural change in the automotive parts and components industry. The late 1970's were a period during which the confluence of major trends in technology, markets, products, regulations and the worldwide motor vehicle industry reached a crisis stage for many suppliers. The trends are highly interrelated, but the catalyst which triggered the inevitable structural change was U.S. consumer auto buying behavior. The combination of the rapid shift in consumer preferences to small fuel-efficient vehicles, coupled with an economic downturn resulting in a decline in total vehicle sales, exacerbated the already delicate situation of independent parts and component suppliers. During the decade of the 1970's suppliers had experienced the following:

- Increased government regulation of their products, the products of their OEM customers, and their manufacturing facilities (EPA, OSHA)

- Increased pressure from OEM customers for improved quality and lower prices on standard parts and components, i.e., shrinking margins

- Significant reduction in the OEM market for components as Japanese vehicle manufacturers (hence Japanese suppliers) gained market share

- The beginning of technological changes (now rapidly accelerated) to motor vehicles that made many traditional products obsolete and required investment in R&D and new manufacturing facilities.

What appears to be emerging are major structural changes in the supplier industry in the following areas:

- Automaker/Supplier Relationships
- Technology Shifts Affecting Markets and Products
- Diversification and Broader Market Perspectives
- Emphasis on Quality and Productivity.

Each is discussed below, but all are interrelated.

2.4.1 Automaker/Supplier Relationships

In the 60's when product innovation was not extensive and there was a limited need for research and capital investment, single-year contracts between automakers and suppliers were common. Under the highly competitive bidding system, profit margins were thin and suppliers did not have the working capital or the sales security to do extensive research and development or invest in new manufacturing facilities. There was also a trend toward vertical integration in the auto industry with the automotive manufacturers buying supplier companies to assure supply and increase profits.

In the early 80's the situation is radically changed as domestic vehicle manufacturers are investing $70 to 80 billion to radically change the design of their products and the facilities in which these products are made. Domestic manufacturers' resources are stretched as declines in sales eat into available capital. Increasingly, vehicle manufacturers are turning to suppliers for new products. Suppliers who are willing to share the risks of innovation now have opportunities for multiyear negotiated contracts, as manufacturers will be forced to rely on the technical expertise of suppliers. Automakers are no longer inclined to purchase suppliers but instead are calling for strong competitive research and development activities by an independent supplier industry. Suppliers with the capability to perform in this new environment can grow and prosper. Others who fail to recognize and respond to the winds of change will find rapidly shrinking markets for their outdated products.

2.4.2 Technology Shifts Affecting Market and Products

Changing automotive technology and downsizing are affecting specific parts and components markets in different ways. For the most part, though, suppliers seem to feel downsizing is helping their businesses. A survey of 200 major supplier companies, conducted by Ward's Auto World, found that 57 percent of the respondents felt automotive downsizing was having a positive effect on their companies and products while only 25.5 percent felt the effect was negative. One vendor commented that the company had short-term cash flow problems but the long term looked good. Another commented that downsizing had improved the company's product development areas and stimulated manufacturing and research areas.

Some of the ways in which downsizing and fuel-efficient vehicle design are affecting product areas are listed below.

- Frames. Frame makers are building smaller and lighter frames and using new materials. Unibody designs are making traditional frame manufacturing facilities obsolete.

- Wheels. Wheel manufacturers are investigating aluminum wheels and composite material wheels.

- Brakes. Brakes are being designed to be smaller and lighter. Aluminum and plastic parts are being incorporated.

- Roller bearings. Bearings for wheels using smaller tires must be redesigned for different loads and greater wear. Also, front-wheel-drive vehicles will use new bearing designs.

- Batteries. Research is continuing in smaller, lighter nickel-based batteries which would be useful in smaller front-wheel-drive cars.

- Exhaust systems. New exhaust systems are necessary for diesel designs, and pollution regulations are leading to newer catalytic converter designs.

- Engine and drivetrain components. Fewer valves and springs will be needed on four-cyclinder cars, and new transaxles, differentials and constant velocity joints will be needed for front-wheel-drive vehicles.

- Steering and Suspension. Rack and pinion steering is rapidly displacing traditional designs. A host of new suspension system designs typical of small European vehicles are being introduced.

- Shock absorbers. The conventional shock absorber is being replaced by MacPherson struts for front-wheel-drive cars.

- Electrical parts. Computers for computer-controlled engines will be almost universally used on cars in the 80's to reduce pollution and improve fuel economy. Microprocessor control of many vehicle systems and accessories will trigger an explosive growth in electronic applications in motor vehicles.

- Fuel systems. Fuel economy and emissions control on spark ignition engines and the growth of the diesel-powered vehicle market are stimulating a great demand for fuel injection systems.

- Supercharging: Demands for both performance and fuel economy have opened up new possibilities for power boosting equipment, i.e., turbochargers.

- Chassis and body materials, trim, etc.: Substantial shifts to lighter weight materials will make obsolete many existing supplier's facilities/processes; as aluminum, plastics, alloy steels, and composite materials are selectively introduced.

In general, the larger suppliers are already committed to R&D and product strategies emphasizing high-technology, fuel efficiency-related components. The smaller suppliers (vendors) and suppliers with narrow current product ranges are less receptive to change.

2.4.3 Diversification and Broader Market Perspective

The OEM auto market has traditionally been cyclical, and the major changes in automotive technology as a result of the push for fuel economy have made the market more volatile than ever. Thus, over the past ten years many auto suppliers have been diversifying to reduce their dependence on the OEM market or the auto industry in general. As a result, some companies have been able to reduce the effects of auto industry downturns on corporate profits, and this has made them more secure in their dealings with Detroit.

Another trend for the suppliers is increasing attention to the European market. Vehicle registrations are growing faster in Europe than they are in the U.S. and are expected to do so through the 1980's. The emergence of a "world car" philosophy on the part of major worldwide automakers will open up broader opportunities for component sales, but will also mean strong international competition from European and multinational suppliers with an edge in small car component technology.

2.4.4 Emphasis on Quality and Productivity

As a result of pressure from high-quality Japanese imports, service complaints and product defect litigation, the U.S. auto manufacturers and their suppliers are presently making a major push to improve quality. Many suppliers are instituting new quality-control programs.

Some suppliers are making substantial investment in new automated plants and equipment. In 1976, suppliers were principally located in the North Central region of the country and highly concentrated in the states of Ohio, Indiana, Michigan, Pennsylvania and Illinois, with three-quarters of the value of parts/components shipments originating in this North Central region. In an increasingly competitive and labor-intensive manufacturing business, automotive parts and components suppliers are showing a marked trend to make facility investments in geographic areas outside of their traditional geographic locations. The summary profiles at the end of this chapter show a strong propensity to locate new plants in the "sun belt" regions and in foreign countries. As will be discussed later in this report, investment in new United States plants by foreign suppliers are also following this "sun belt" trend.

The long-term overall productivity implications inherent in this apparent geographic dispersion of supplier facilities has not as yet been studied. The Japanese automotive manufacturing model as exemplified in the tight grouping of vehicle manufacturing and suppliers in Toyota City raises serious questions about this decentralization trend in U.S. automotive manufacturing.

* * * * *

The following one-page summary profiles of the companies designated in Tables 2-1 and 2-2 may be found in the following appendices:

Appendix A North American Automotive Parts and Components Suppliers

Appendix B Multinational Automotive Parts and Components Suppliers

Appendix C Foreign Automotive Parts and Components Suppliers.

3. THE MACHINE TOOL INDUSTRY

The U.S. machine tool industry is a relatively small but critical component of the national economy, and it has historically been basic to the development of the American auto industry. The close relationship between the two industries is particularly important now, when the automakers are in the midst of a major retooling effort to meet Federal fuel efficiency mandates.

Automobile design changes and similar programs in the aerospace industry have been major factors in the ongoing, three-year order boom for machine tool suppliers. Spending for machine tools in the U.S. may reach $6 billion in 1980, up from $4.5 billion in 1979.

The surge in orders is not without its problems, however. Because of the traditional cyclicality of the machine tool demand, suppliers have been reluctant to expand their operations to meet order levels that may be only temporary. That reluctance has left the major machine tool manufacturers without the necessary capacity to meet the current high level of demand. Order backlogs for the industry as a whole are running more than $5.6 billion, and delivery times for many machines have stretched out to over two years.

Huge backlogs and long lead times have aggravated the problem of foreign competition. The automakers and other manufacturers are shopping around in foreign markets in efforts to speed up the installation of new equipment. The U.S. machine tool manufacturers are acutely aware of the problem and have recently stepped up their capital expansion programs and accelerated development of more sophisticated machining systems tailored to the new requirements of the auto and aircraft industries. The suppliers are paying particular attention to the design of more flexible manufacturing systems and to the development of more powerful computer controls for their machines. In the short run, at least, the level of orders for these new systems will depend heavily on the auto manufacturers' confidence that the equipment will be ready when they need it.

Because of continuing demand for machine tools in the auto and aircraft industries, the general recession has not seriously affected the machine tool suppliers. This situation is likely to continue through 1980. Some analysts predict a slowing of sales beginning in early 1981. The machine tool industry, however, is confident that its recent growth will continue into the mid-'80s. In making that forecast, the industry points to the country's widespread concern with raising manufacturing productivity and with compensating for the shortage of skilled labor through the use of more sophisticated and automated machinery.

3.1 SIZE AND STRUCTURE OF THE U.S. MACHINE TOOL INDUSTRY

The machine tool industry is relatively small compared to other U.S. industries. Many giant industrial corporations report more shipments and more employees than the entire machine tool industry. Figure 3-1 compares the value of shipments of the machine tool industry with three other durable goods manufacturing industries. As shown, machine tool shipments of $3.6 billion in 1976 were relatively small compared to such industries as the motor vehicle industry and the construction machinery industry. The value of machine tool industry shipments, however, was roughly equivalent to that of the special tool and die industry. In 1976 the machine tool industry employed approximately 81,000 workers, about 10 percent of the number of people employed in the motor vehicle industry.

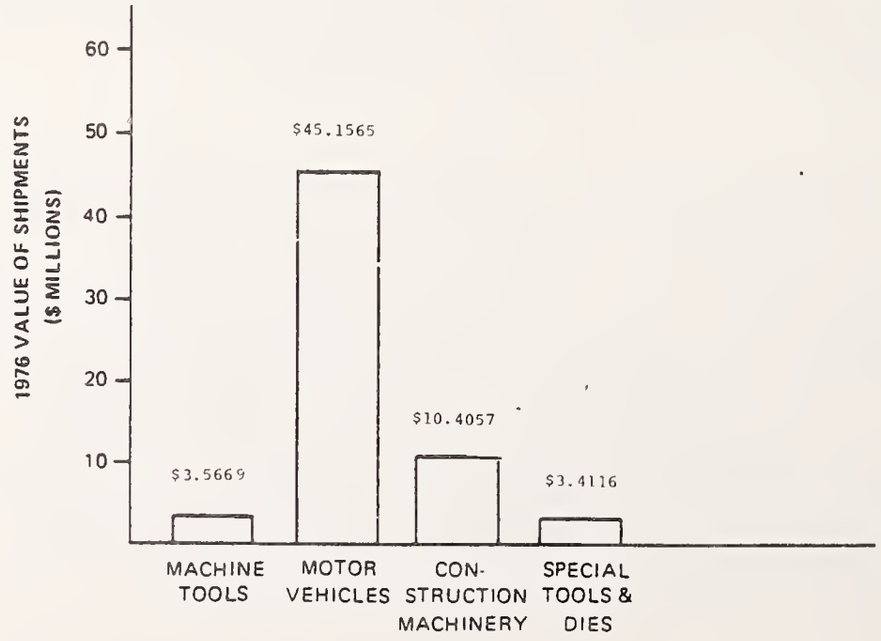


FIGURE 3-1. COMPARISON OF VALUE OF SHIPMENTS OF SELECTED MANUFACTURING INDUSTRIES

The machine tool industry has shown considerable growth over the last ten years. Machine tool purchases of $1.4 billion in 1970 had reached $4.5 billion in 1979. Some industry observers have predicted $6 billion in sales in 1980.

The machine tool industry is often referred to as a small shop industry. As shown in Table 3-1, almost 50 percent of the establishments have less than 10 employees and only 7 percent of the establishments have more than 250 employees. The large shops, 250 employees or greater, however, do produce the majority (approximately 58 percent) of the machine tool shipments.

TABLE 3-1. STRUCTURE OF THE MACHINE TOOL INDUSTRY BROKEN DOWN BY NUMBER OF EMPLOYEES

Employment Size	Number of Establishments	Value of Shipments (Millions)	Market Share
All Establishments	1,277	$2,111.7	
1 to 4 Employees	380 (30%)	25.2	1%
5 to 9 Employees	212 (17%)	38.0	2
10 to 19 Employees	246 (19%)	86.3	4
20 to 49 Employees	194 (15%)	166.0	8
50 to 99 Employees	89 (7%)	183.8	9
100 to 249 Employees	83 (6%)	376.0	18
250 to 499 Employees	37 (3%)	383.7	18
500 or More Employees	47 (4%)	855.5	40

Source: 1972 Census of Manufacturers.

3.2 MAJOR MARKETS FOR MACHINE TOOLS

Machine tool products can be divided into two major market categories:

- Production machine tools, such as lathes, drill presses and so forth sold to a wide variety of industries
- Specialized machine tools, including completely automated manufacturing systems, sold to large manufacturers such as the automobile and the aircraft industries. The automobile has its greatest impact on this market segment.

The recent surge of orders for machine tools by the automotive and aircraft industries has been due to the introduction and planned introduction of new products by both industries. The National Machine Tool Builders Association estimates that the auto industry currently accounts for 20 to 25 percent of all new orders for machine tools in the U.S.

The automakers use machine tools for a wide variety of operations, including stamping bumpers, drilling engine blocks, turning brake drums, cutting gears and forming vehicle bodies. Figure 3-2 illustrates some of the parts and components commonly manufactured with the use of machine tools.

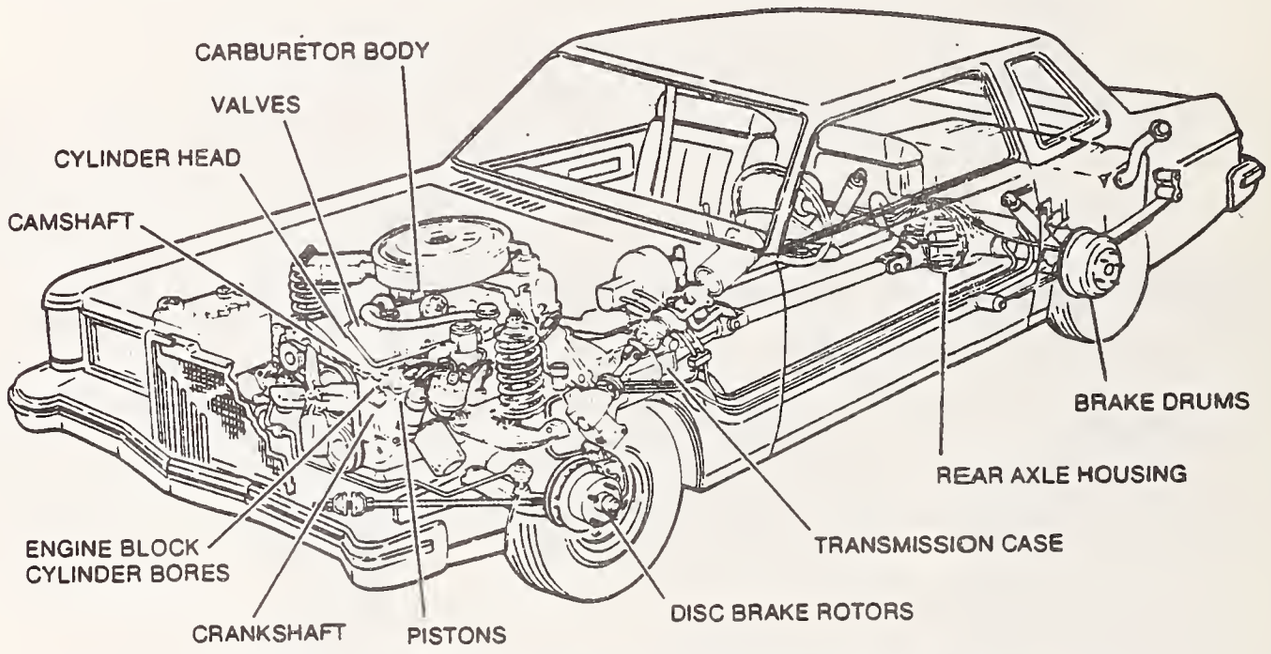


FIGURE 3-2. SCHEMATIC DIAGRAM OF AUTOMOBILE SHOWING PARTS AND COMPONENTS WHICH ARE MACHINED

3.3 MACHINE TOOLS TECHNOLOGY

Machine tools can be categorized by their machining operations and by their configurations. There are two broad groups of machining operations: metalcutting and metal-forming. This report concentrates on metalcutting machine tools, which account for 75 percent of total U.S. machine tool sales. Configurations of machine tools are varied, and the number of designs is increasing as machine tool users demand machines that are capable of performing multiple operations with increasing levels of efficiency and versatility.

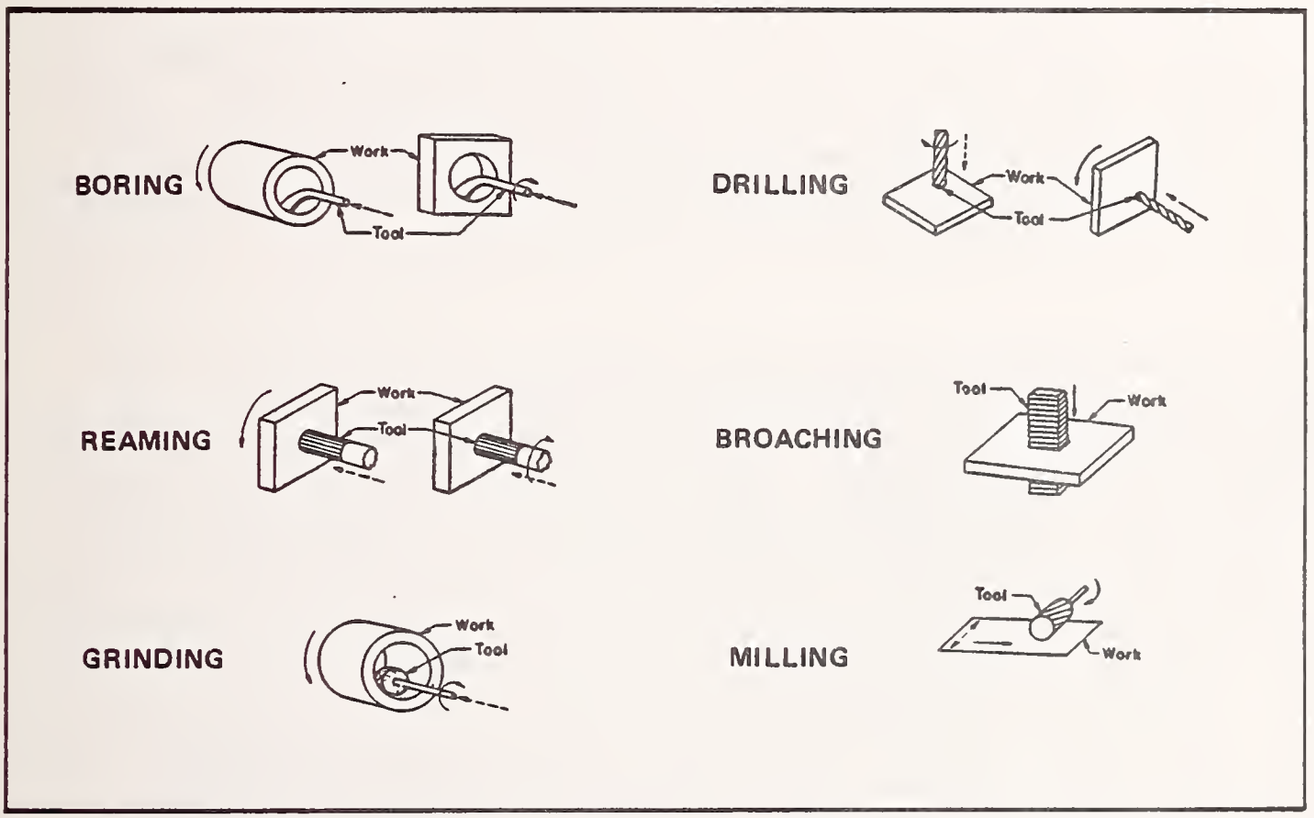
3.3.1 Basic Metalcutting Tools

Basic metalcutting operations are illustrated in Figure 3-3. Five basic types of machine tools which are commonly categorized by their operation are described below.

Turning Machines

Turning machines are based on the principle of the lathe--cutting excess metal, in the form of chips, from the external or internal diameter of a rotating workpiece. Internal cylindrical operations that are performed in turning machines include drilling, reaming, threading and boring. Boring involves enlarging and finishing a hole that has been cored or drilled.

FIGURE 3-3. BASIC METALCUTTING TOOLS



Modern turret lathes are equipped with a turret containing multiple tools and are frequently classified as either chucking machines or bar machines. Bar machines, sometimes called screw machines, are designed for machining small threaded-type parts, bushings and other small parts from bar stock fed into the machine spindle. Chucking machines are used for machining larger parts, such as castings, forgings or blanks of stock that must be mounted in workpiece holders (chucks) manually.

Drilling Machines

Drilling machines, also called drill presses, cut holes in metal with twist drills. They also use a variety of other

cutting tools to perform basic hole-machining operations, such as reaming, boring, countersinking and tapping internal threads.

Milling Machines

Milling machines cut metal as the workpiece is fed against a rotating cutting tool called a milling cutter. Various cutters are used for cutting concave forms, convex grooves, rounding corners and cutting gear teeth.

Grinding Machines

Grinding machines remove small chips from metal parts that are brought into contact with a rotating abrasive wheel, called a grinding wheel, or with an abrasive belt. Grinding is the most accurate of all the basic machining processes and is often the last operation performed on automotive parts and components prior to final assembly.

Broaching Machines

Broaching machines are special-purpose machines used for cutting keyways in the hubs of gears or pulleys, cutting square or hexagonal holes and cutting gear teeth. The teeth on broaching tools are equally spaced but increase in size from the tip of the tool upward. Each tooth cuts more deeply into the workpiece, and the broaching operation is completed in a single stroke.

3.3.2 Machine Tool Configurations

Machine tool products are often combinations of basic tools. Many are systems that consist of several machines connected by conveyor systems. Others are multiple-function systems that are numerically controlled, often by computers. The major categories of machine tool configurations that are important to the auto industry are described below.

Transfer Lines

The largest and most expensive machines sold to the auto industry are transfer lines. They are combinations of conventional machine tools arranged in the required sequence, connected by work-transfer devices and integrated with interlocking controls. Maximum production economy on transfer lines is often achieved by assembling parts to the workpieces during their movement. The systems often reach several hundred feet in length, and loading and unloading operations take place at each end of the line. While the largest lines are usually laid out in a straight line, smaller pieces are often machined on lines with circular pathways, called dial machines.

Transfer lines fall into the more general category of special-purpose machines. They are dedicated equipment--designed and built for the production of a specific set of parts or components. This custom construction provides high production rates and maximum machining efficiency, but it renders the equipment largely inflexible. Given the rapid changes taking place in the auto industry and frequency of design and tooling innovations, machine tool suppliers and automakers are experimenting with more flexible alternatives to the traditional Detroit transfer line.

Machining Centers

Machining centers are numerically controlled machine tools that can perform a multiplicity of operations in only one setup. They constitute a relatively new class of machine tools, made possible by the advent of numerical controls and expanded in their capabilities by the introduction of computer numerical controls.

The controller on a machining center can adjust three, four or five axes, setting the positions of the column, spindle head table location, table rotation and table tilt. By changing these variables and utilizing a tool magazine, a center is capable of performing a wide variety of operations, including milling, drilling, reaming, contouring, tapping, and boring. Machining centers replace an average of three conventional machine tools. They are used more frequently in job shops that supply the auto companies than in the auto plants because they are not high-volume machines.

Flexible Machining Systems

For the most part, flexible machining systems are still drawing board designs rather than production realities. However, discussions of their potential applications, particularly for the auto and aircraft industries, dominate the medium-term marketing deliberations of the major machine tool suppliers. The basic concept of the flexible machining system is the wedding of transfer line automation with the adjustment capabilities of machining centers. Computer numerically controlled machining centers would be linked together by work-transfer devices to provide a continuous machining line capable of machining over 100 different parts. The systems would, therefore, differ from transfer lines in two respects: they would be slower, and they would be much more versatile.

A primary motivation for designing and building flexible machining systems is the increasing frequency of design and tooling changes in automobiles and aircraft. Until recently, major manufacturing industries, such as auto, used a machine

tool to make a product with a life nearly equal to that of the equipment. That is no longer the case. Continuous and radical product changes have placed a four or five year limit on the lifespan of most machined products. At General Motors, for example, not one engine in production for its 1978 car models will still be in production for its 1985 models.

Although transfer lines allow for some limited production changes, any significant design alterations make them obsolete. Flexible machining equipment would allow manufacturers to alter parts and components without requiring the enormous capital costs of entirely new machining lines.

3.4 MACHINE TOOL COMPANIES

There are over 1,200 companies at present in the U.S. which manufacture machine tools. Approximately 67 percent, however, are small, closely held companies. Major domestic suppliers of machine tools include:

- Acme Cleveland
- Cincinnati Milacron
- Bendix/Warner and Swasey
- Cross and Trecker
- Ex-Cell-O Corporation (Kingsbury)
- Ingersoll-Rand Company
- Motch & Merryweather
- F. Jos. Lamb Company
- Place (Budd)
- Snyder
- Giddings and Lewis
- Colt Industries.

Table 3-2 lists the key financial indicators of the major suppliers listed above.

The companies covered in this report were chosen from among the largest machine tool suppliers in the U.S. The list was narrowed down by concentrating on those companies that are most important to the auto industry. Companies that are subsidiaries of firms that have already been covered in previous reports under this contract, such as Budd and Bendix, were eliminated. The final selection process was made on the basis of the availability of information about the companies. The selected companies were:

- Acme Cleveland
- Cincinnati Milacron
- Cross and Trecker
- Giddings and Lewis
- Lamb
- Motch and Merryweather.

TABLE 3-2. MACHINE TOOL SUPPLIERS' FINANCIAL ANALYSIS

Company	1979 Net Sales (Millions)	1979 Net Earnings (Millions)	Percent Change Over 78	Percent Return On Sales
Acme-Cleveland	$ 344.4	$ 19.6	+ 49	5.7
Cincinnati Milacron	747.9	55.4	+ 67	7.4
Bendix	3,856.4	162.6	+ 25	4.2
Warner and Swasey	305.0	21.5	+ 84	7.0
Cross and Trecker	298.0	26.4	+ 54	7.2
Ex-Cell-O Corp.	961.9	54.2	38	5.6
Snyder	38.0	1.5	NA	4.0
Giddings and Lewis	257.7	28.9	+ 59	11.2
Colt	2,140.5	114.4	+ 28	5.2
Jos. F. Lamb Co	200 +	(Privately held)		
Motch & Merry-Weather	NA*	NA	NA	NA
Place	NA**	NA	NA	NA

Jos. F. Lamb Co. 200.0 + 85 (privately held--data not available)

N.A. = Not Available
* Aquired 1979 by Oerlikon-Buhrle
** Acquired1980 by Budd

3.5 TRENDS AFFECTING THE MACHINE TOOL INDUSTRY

The U.S. machine tool industry is at an important juncture. Accustomed to an historical boom/bust cycle, the industry is now experiencing a sustained, high level of demand, and it is not capable of meeting the incoming orders. At the same time, it is faced with tough competition from overseas machine tool suppliers and demands from its customers for technologically advanced products. In the coming period, four trends can be isolated that will significantly shape the future of the industry:

- Demand for machine tools that are more technologically advanced

- Attempts to alleviate the severe capacity constraints of domestic machine tool builders

- Encroachment of foreign companies into U.S. markets

- Increasing consolidation of the industry through mergers and acquisitions.

3.5.1 Technical Advances

Advances in electronics are leading the way toward a new generation of more highly automated and more dependable machine tools. Although less than 5 percent of machine tools in use are equipped with numerical control, the latest generation of machine tools is making increasing use of this powerful feature. Tape-controlled systems of earlier models are giving way to programmable control systems governed by software. Programmable controllers have opened up the possibility of flexible machining systems (described above) and of integrated manufacturing systems that combine numerically controlled machines, automated handling systems, industrial robots and computer-centered management information systems. Programmable systems will offer manufacturers the following advantages:

- Provide random and flexible manufacturing for a family of workpieces, i.e., the capability to introduce any workpiece into the system at any time without any system downtime

- Provide management control through joint implementation of computers, numerical control machine tools and automated material handling

- Increase utilization of facilities through the inherent flexibility of programmable systems.

Although electronic system controls may have the most far-reaching impact on machine tool applications, other important areas of research are also being explored and applied. They include:

- In-line gauging to make automatic incremental adjustments to compensate for tool wear

- In-process inspection and testing stations to improve quality control

- Reductions in the use of coolants, a consistent source of environmental and maintenance problems

- Development of coated carbide cutting tools that have longer tool lives and that allow higher machining speeds.

3.5.2 Capacity Constraints

Since finding itself with excess capacity in the economic slowdown of the late '50s and early '60s, the U.S. machine tool industry has been wary of significantly expanding its production capacity. This long-held attitude has recently begun to change in the face of strong, sustained demand, huge order backlogs and the spectre of foreign incursion into U.S. markets.

New capital expenditures by machine tool builders declined from $104.9 million in 1967 to $91.7 million in 1978. In 1979, the level of investment jumped 57 percent to $144 million, and another sizeable increase in expenditures is predicted for 1980. The suppliers are playing catch-up, however. Backlogs are running over $5.6 billion, lead times are stretching to over 24 months and foreign competitors are winning over U.S. customers with considerably shorter delivery schedules. The transfer line requirements of General Motors alone could absorb the entire capacity of the transfer line segment of the industry for the next four years.

Compounding the suppliers' problems is a serious shortage of skilled machinists. Total employment in the industry dropped by 34 percent between 1967 and 1972, from 116,400 to 76,600, only rising back to 110,000 in 1979. Industry representatives point to the skilled labor shortage as a critical constraint on expansion, and several of the larger companies have initiated special training or apprenticeship programs to help fill the gap.

3.5.3 Foreign Competition

The mounting backlogs of U.S. machine tool suppliers has aggravated the industry's problems with foreign competitors. Foreign producers have captured 25 percent of the U.S. market, and observers are predicting that the percentage will continue to rise as domestic delivery times lengthen. Japanese firms, which account for 34 percent of U.S. machine tool imports, increased their U.S. sales 70 percent in 1979 over the previous year, to $386 million. West German exports rose 27 percent during the same period.

In addition to stepping up their exports, the foreign producers are setting up production and assembly facilities in the U.S. Fifteen foreign machine tool manufacturers have built plants in the U.S. since the mid-'70s, and several others have

purchased important domestic tool companies. Recent transactions include the purchase of Motch & Merryweather by Oerlikon-Buhrle Holding of Switzerland and the acquisition of Place Machine Sales by the West German steel company Thyssen.

Steady technological advances by the Japanese competitors have also caused concern in the U.S. industry. The Japanese exported 2,300 numerically controlled lathes to the U.S. in 1979--40 percent more than were produced by U.S. companies. Exports of Japanese-built machining centers have also jumped dramatically in the last five years. Most analysts think that the U.S. will continue to hold its lead in computer technology, particularly software, but the technological gap between the domestic and foreign suppliers is definitely narrowing.

3.5.4 Industry Consolidation

The demand for rapid technical progress, capacity limitations and the strength of foreign competition are all having major effects on the structure of the U.S. machine tool industry. Smaller companies are encountering difficulties in financing the necessary expansion and research work required to remain competitive, and larger firms are merging their operations to pool technical talent and capital resources.

Two of the largest mergers ever in the industry occurred in 1979. Most recently, the Bendix Corporation purchased the Warner & Swasey Company of Cleveland. Earlier in the year, the Cross Company of Detroit and the Kearney & Trecker Corporation of Milwaukee combined to form Cross & Trecker. The Justice Department has brought suit against the second merger for anti-trust violations, but other mergers are being announced or negotiated. Giddings & Lewis has announced that it was discussing a merger with Motch & Merryweather before the latter was bought up by Oerlikon of Switzerland.

* * * * * *

Appendix D consists of one-page summary profiles of major machine tool companies serving the auto industry, identified earlier in this chapter.

4. STEEL INDUSTRY

Ever since the Bessemer process of making steel economically was perfected in the 1850's, the steel industry has been a cornerstone of the industrial might of this country. Since about the 1920's, when steel replaced wood as the primary material for making automobiles, the two industries, automobile and steel, have been virtual partners in the business of building and selling the more than 100 million automobiles on the road in America today.

Every automobile that rolls off the assembly line is 50 percent steel, making steel the dominant material in automaking. The automotive community is also the steel industry's largest single customer, accounting for nearly 20 percent of all domestic steel shipments.

4.1 SIZE AND STRUCTURE OF DOMESTIC STEEL INDUSTRY

4.1.1 Size of Industry

Shipments of steel mill products in 1979 were 100.3 million tons up from 97.9 million tons in 1978. Sales totaled $56.7 billion in 1979, up 18.9 percent over the 1978 total of $47.7 billion. Net income for the industry declined by 7 percent from $1.4 billion in 1978 to $1.3 billion in 1979. Industry employment was about 450,000 persons in 1979. (See Table 4-1.)

TABLE 4-1. U.S. STEEL INDUSTRY
SHIPMENTS, SALES, INCOME AND EMPLOYMENT

	1979	1978	Percent Change 1979 over 1978
Shipments (Millions of Tons)	100.3	97.9	+2.5
Sales (Billions)	$ 56.7	$ 47.7	+18.9
Net Income (Billions)	$ 1.3	$ 1.4	-7.1
Total Employment: 450,000 (1979)			

4.1.2 Structure

Figure 4-1 illustrates the structure of the steel industry. As shown by the shaded boxes in the diagram, the steel industry consists primarily of three types of operations:

- Mining Operations, i.e., companies or divisions of companies which specialize in extracting raw materials from the earth such as iron ore. These operations—often owned by the steelmakers—are also involved in shipping these raw materials to refineries for processing.

- Refining Operations, i.e., facilities which specialize in converting the raw materials plus scrap metal into a primary product, such as iron or steel.

- Finishing Operations, i.e., facilities which specialize in converting the raw steel into various sizes, shapes and forms such as bars, rods, sheets, plates, and wire. In many cases the refining and finishing operations are combined in one huge facility, or grouping of facilities.

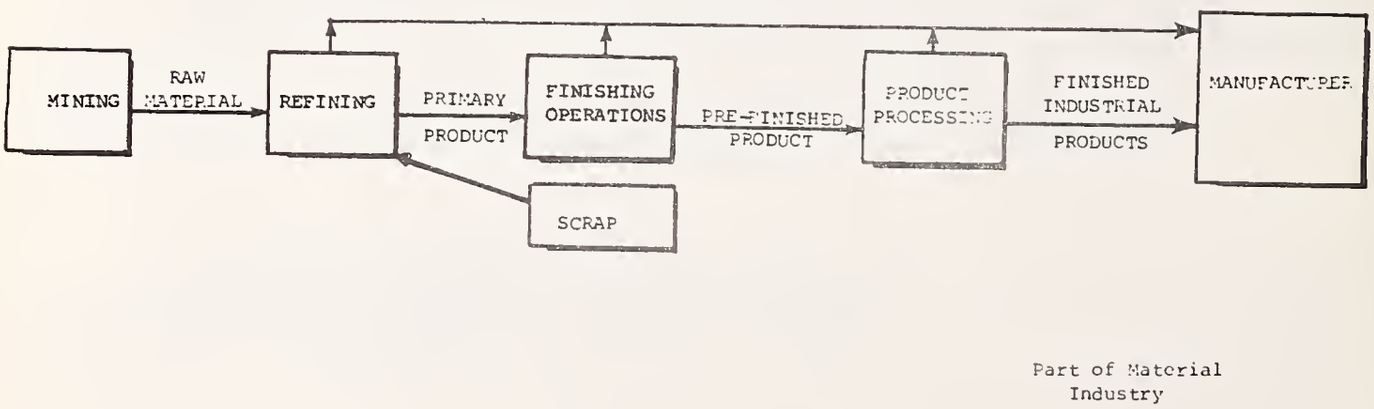


FIGURE 4-1. STRUCTURE OF STEEL INDUSTRY

The Steelmaking Process

Basically, a steelmaking operation begins by mixing iron ore, coke (baked coal) and limestone in a blast furnace. Under intense heat in the blast furnace, the iron ore is reduced to molten iron. The iron is then moved to an open hearth furnace, basic oxygen furnace, or electric furnace where the iron is converted to steel by removing carbon in the iron. Alloying agents are also added at this time to form various grades of steel. The open hearth furnaces and electric furnaces can run on an 85 percent and 100 percent scrap metal charge respectively, thus eliminating the molten iron production step. From the steelmaking furnaces the metal is ladeled into molds, where the liquid solidifies into ingots.

The ingots, still hot on the inside, are placed in hot soaking pits to achieve uniform temperature throughout, and then transferred to hot rolling mills, where they are transformed into slabs, blooms or billets. The slabs, blooms and billets are then made into hot and cold rolled plate, sheet and strip steel, structural steel and rails, or bars and rods.

A recent development, continuous casting, has eliminated the making of ingots. In this process, molten steel is taken directly from basic oxygen furnaces and run through giant rollers which produce continuous slabs, blooms or billets. One U.S. steelmaker, National Steel, currently produces 40 percent of its steel slabs with this process, a figure which is on a par with the average for all Japanese steelmakers. Other U.S. steelmakers cast a far smaller percentage of their steels.

Dominant Companies

Over 70 percent of industry sales and shipments were captured by seven steelmakers in 1979. Each of the seven major steelmakers is fully integrated, which means in essence that each controls, to varying degrees, all three of the basic steelmaking operations. Each has its own mining operations, each produces great quantities of refined (raw) steel, and each produces millions of tons of finished steel annually.

Because the seven top steelmakers command such a controlling share of steel production, and because all work so closely with the automotive community, this report will deal exclusively with these producers. Table 4-2 identifies and summarizes the 1979 performance of these seven firms in terms of sales and shipments.

TABLE 4-2. PERFORMANCE OF SEVEN LARGEST STEELMAKERS. (1979)

Company	Sales ($ Billion)	Shipments (000 Tons)
U.S. Steel	$12.93	21,000
Bethlehem Steel	7.14	13,436
*LTV (J&L & Youngstown Steel)	4.17	8,538
Armco	5.04	6,004
National	4.23	8,258
Republic	3.99	7,374
Inland	3.64	6,036
Seven Company Total	41.14	70,646
Seven Companies as Percent of Total Industry	72.6	70.5

* LTV figures are those for combined J&L and YS&T operations, not for entire corporation.

4.2 PRODUCTS OF THE STEELMAKERS

Although the steel industry produces more than 130 million tons of raw steel annually, its principal products are the finished steels it makes from this raw steel. These are hot and cold rolled sheet and strip carbon steels, carbon steel plate, steel bars and rods, structural steel shapes, galvanized steels and special steels such as high strength/ low alloy steels, increasingly important for automotive use. Some typical automotive applications for steel are:

- Body shell
- Frame
- Suspension components
- Exhaust system
- Fuel tank
- Bumpers
- Wheels
- Gears
- Springs.

4.3 MAJOR STEEL MARKETS

In addition to automotive, which was 18.6 percent of steel industry sales in 1979, other major markets are building and construction, equipment and machinery, containers and packaging, and railroads and shipbuilding. Steel service centers, which sell to a wide variety of local industries, consume 18 percent. Other major steel markets together with their percent of total shipments are shown in Table 4-3.

4.4 MAJOR ISSUES AFFECTING STEEL INDUSTRY

Although 1979 was a good year for the domestic steel industry, the situation began to worsen by the end of the year as declining auto and construction sales and the worsening recession took its toll. By and large, the domestic steel industry is beset by problems and challenges on all sides, and how it is meeting these challenges and coping with these problems may well have profound effects on the automotive industry—and the nation—in years to come. The major issues impacting on the domestic steel industry remain:

- Maintaining steel's share of the automotive market as Detroit struggles to lighten its cars
- Lessening steel's dependence on the automotive community
- Supporting the considerable weight of environmental regulations on its facilities
- Modernizing its facilities to keep the domestic industry competitive with overseas steel producers in both technology and productivity
- Stemming the tide of cheaper imported steels.

Each of these issues are discussed below.

4.4.1 Maintaining Steel's Share of the Market

As America's automakers struggle to cut the weight of their products more and more each year, they are turning to whatever materials will best meet their requirements for light weight, strength, durability, availability and cost. This means, increasingly, that aluminum and plastics are moving into areas once the sole province of steel.

TABLE 4-3. MAJOR STEEL MARKETS

Major Market	Product Shipments (Net Tons)	Percent of Total
Automotive	18,624,000	18.6
Building & Construction	14,078,000	14.0
Equipment Machinery	6,027,000	6.0
Containers & Packaging	6,770,000	6.8
Railroads & Shipbuilding	4,127,000	4.1
Steel Service Centers	18,263,000	18.2
Oil & Gas	3,738,000	3.7
Appliance, Utensils & Cutlery	2,141,000	2.1
Steel for Converting & Processing	5,057,893	5.0
Independent Forgers, NEL	1,254,549	1.3
Agricultural Equipment	1,978,000	2.0
Industrial Fasteners	933,567	.9
Export	2,007,489	2.0
Electrical Equipment	2,821,000	2.8
Other*	12,441,602	12.5
TOTAL	100,262,000	100.0%

* Includes ordnance and other military, aircraft and aerospace, mining.

To counter this, steelmakers have developed whole new families of high strength/low alloy steels, and are working diligently to refine these and other lightweight steels to make them more formable and generally useful to the automakers.

The steelmakers are also expending enormous effort to develop new automotive applications for existing steels—such as stamped rack and pinion components, and experimental stamped steel engine blocks. They have also made significant strides in perfecting anti-corrosion steels that are still highly paintable.

4.4.2 Lessening Steel's Dependence on the Automotive Market

In addition to finding new automotive uses for steels, the steelmakers have embarked on a concerted effort to wean their businesses from over-dependence on the automotive market. One major steelmaker, for instance, sold 31 percent of its products to the automotive market ten years ago, but deliberately reduced this to 21 percent by expanding sales to service centers, consumer durable, appliances, and other markets. This same steelmaker has also secured control of a major West Coast savings and loan association to insulate the company "from the cyclical nature of the steel business."

While most other steelmakers are not going so far afield from steel in their attempts to lessen their dependence on the automotive market, all are working hard to build up their non-automotive markets.

4.4.3 The Burden of Environmental Constraints

Although few could argue convincingly against the need to clean up American industry—especially the steel industry—the economic burden borne by the domestic steelmakers to do so is staggering. In 1977 alone, steelmakers spent more than $1 billion on environmental projects, compared with $2.5 billion for all other capital projects combined.

How much of this would be spent on"normal" capital improvements if it were not being devoted to environmental improvements is hard to say, but the need for modernization of facilities is so severe it appears certain that the environmental expenditures are making it difficult for

steelmakers to keep pace with the rapid overseas technological advances. Environmental regulation additionally boosts operating costs. The Council on Wage and Price Stability estimates that EPA-mandated spending will account for 10 percent of all production costs by 1983. What they cannot recover by raising prices—which puts them at the mercy of low-priced foreign steels—the steelmakers are recovering by slashing research, maintenance and other budgets.

4.4.4 Modernizing Facilities

With or without the burden of environmental constraints, the domestic steelmakers would still need to devote enormous energy and capital to modernizing and improving facilities that lag behind those of Japan and some European Economic Community nations technologically. But faced with possible decline of automotive markets, steelmakers are proceeding cautiously to avoid expending scarce capital at a time when the market appears to be flattening out.

Many steel executives foresee a boom in steel demand by the mid-80's, however, and are reluctant to shut down all their older—and inefficient—plants, lest they be caught with great demand and no way to meet it. But U.S. Steel, as Bethlehem did two years ago, found it could no longer sustain some of its aged plants, and shut several plants down in 1979.

4.4.5 Imported Steel Invasion

Imported steel shipments to the U.S. totaled more than 20 percent of domestic shipments again in 1979. Much of this steel was priced below what U.S. steelmakers can sell it for, and the situation is exacerbated by lower productivity rates and often less-than-competitive steelmaking facilities within the domestic steel industry. The Federal Government's Trigger Price Mechanism appeared to enjoy some success in limiting the surge of imported steel, but was suspended when U.S. Steel launched "dumping" charges against overseas steelmakers. Domestic steelmakers feel the high percentage of imported steel makes it hazardous for them to expand their own facilities into a position of overcapacity.

* * * * *

Appendix E consists of one page summary profiles of the seven steelmaking companies identified in Table 4-2.

5. ALUMINUM INDUSTRY

Since 1966 the motor vehicle manufacturing industry has typically consumed from 9 to 15 percent of all domestic aluminum production. Recently, this amount has been increasing. Compared with the typical car of today, which weighs approximately 3,000 pounds and contains about 112 pounds of aluminum, the typical car of 1985 is expected to weigh 2,700 pounds and contain from 200 to 240 pounds of aluminum.

5.1 ALUMINUM MANUFACTURING PROCESS

Bauxite is the raw material for aluminum production and it is refined in "alumina plants" into alumina, an oxide of aluminum. (See Figure 5-1.) In a separate smelting plant, or primary aluminum plant, the alumina is converted into aluminum. This process requires a powerful electric current to wrest the aluminum from the oxygen.

Molten aluminum is usually cast into ingots which are shipped to fabricating plants for further processing. The most important aluminum products for the auto industry are sheet products and castings. To make sheet products, the ingots are sent to rolling mills where they are rolled into flat sheets or coils. For castings, the primary ingots are sent to aluminum foundries where they are remelted and cast into new products.

Much of the metal used in aluminum foundries comes from secondary or recycled ingot. Most of this metal comes from remelting aluminum cans collected throughout the country. The remelting process uses only about five percent of the energy originally required to make aluminum.

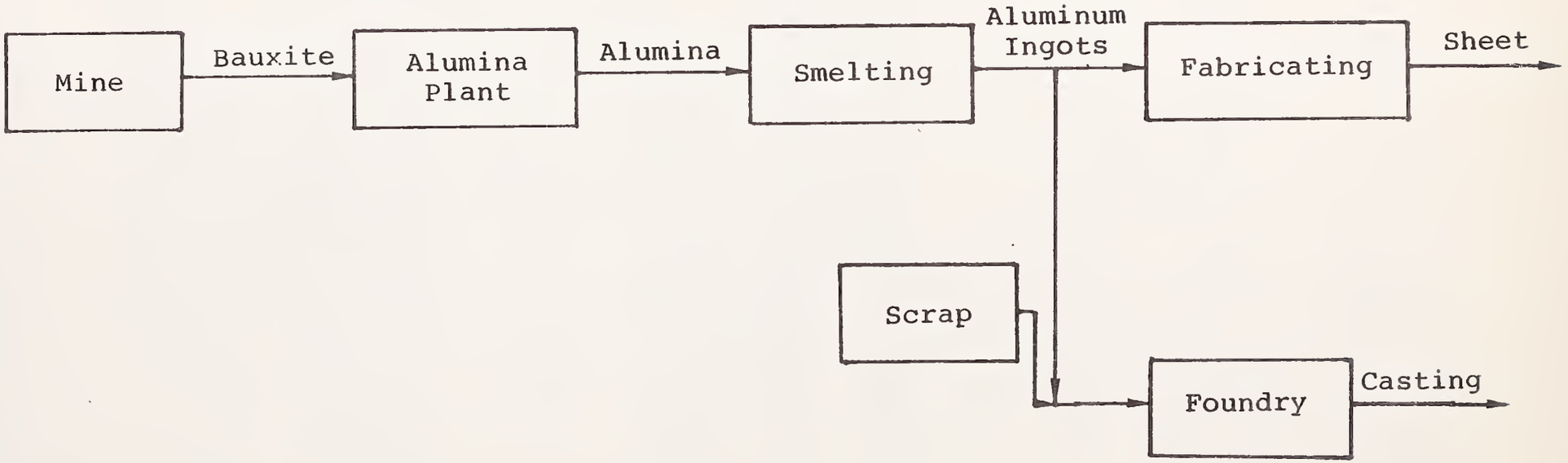


FIGURE 5-1. THE MANUFACTURE OF ALUMINUM

5.2 SIZE AND STRUCTURE OF THE INDUSTRY

The aluminum industry is dominated by six major companies, three of which are headquartered in the United States. Many of the aluminum companies are vertically integrated and participate in all stages of aluminum production from mining to fabrication.

5.2.1 Size of Industry

In 1979, the American aluminum industry shipped about 14.6 million pounds of primary and secondary ingot and mill products such as sheet, plate, strip, etc., having a value of about $14 billion. An estimated 200,000 to 250,000 people are employed by the aluminum industry in the United States. Domestic aluminum use is expected to more than double in the next 25 years.

5.2.2 Industry Structure

The world aluminum industry consists of six large integrated firms, which own or have equity interests in about half of world aluminum productive capacity, and about 50 other companies, which own a quarter of aluminum productive capacity, frequently in association with one or more of the six large firms.

Three of the six large aluminum companies are in the United States. These are ALCOA, Reynolds, and Kaiser, who together account for 65 percent of domestic primary aluminum capacity. The fourth, fifth, and sixth largest aluminum companies in the United States, in terms of capacity, are Consolidated Aluminum, Anaconda, and Alumax. (See Table 5-1.) This report covers the three largest U.S. producers plus Alumax. Alumax is included because it is the only company undertaking major primary aluminum expansion in the United States. In addition, this report covers Alcan Aluminum, Ltd., a Canadian company with the largest primary aluminum capacity in the world. Alcan has a substantial market in the United States.

TABLE 5-1. MAJOR ALUMINUM COMPANIES

COMPANY	1979 SALES ($ Millions)	PRIMARY CAPACITY (Thousands of Tons)
ALCOA	4,786	1,770
Alcan	4,441	1,722
Reynolds	3,305	975
Kaiser	2,927	724
Alumax	873	219

5.3 MAJOR MARKETS

In the United States the aluminum industry has identified its major markets as building and construction, transportation, consumer durables, electrical, machinery and equipment, containers and packaging, exports and other end uses. Table 5-2 shows the distribution of sales to these markets.

TABLE 5-2. SHIPMENTS BY MAJOR MARKET, 1979

MAJOR MARKET	PRODUCT SHIPMENTS (Millions of Pounds)	PERCENT OF TOTAL
Building and Construction	3,052	20.1
Transportation	3,024	20.1
Consumer Durables	1,009	7.0
Electrical	1,559	10.7
Machinery and Equipment	934	6.4
Containers and Packaging	3,223	22.0
Other	810	5.5
Total Domestic	13,611	93.0
Exports	1,023	7.0
TOTAL INDUSTRY	14,634	100.0

Source: Aluminum Association estimates.

As shown in Table 5-2, the most important markets are building and construction, containers and packaging, and transportation. The major aluminum products used in the manufacture of passenger cars are sheet and ingots. Table 5-3 gives the complete breakdown of aluminum use in cars by product type from the aluminum industry.

TABLE 5-3. TOTAL ALUMINUM USE IN PASSENGER CARS, 1978

(MILLIONS OF POUNDS)

PRODUCT	QUANTITY	PERCENT OF TOTAL
Ingot	961	64.4
Sheet	394	25.5
Foil	41	2.4
Rolled and Continuous Cast Rod and Bar	11	0.7
Extruded Shapes	77	3.9
Extruded Pipe and Tube	14	0.9
Drawn Tube	13	0.9
Bare Wire	1	0.1
Forgings	14	1.0
Impacts	3	0.2
TOTAL	1,529	100.0

5.4 MAJOR ISSUES AFFECTING THE ALUMINUM INDUSTRY

The principal issues affecting suppliers of aluminum to the auto industry include:

- Rising energy costs
- Inadequate returns
- Increased sales of sheet.

Rising Energy Costs

Aluminum requires large amounts of electrical energy for its production, and the problems of the power industries in the United States have been partly responsible for the lack of new domestic primary aluminum smelters. Besides ALCOA's Anderson County, Texas, experimental smelter, only one new smelter is under construction in the United States—Alumax's new South Carolina plant. Reynolds is considering expanding its primary capacity through modernization of existing facilities. Kaiser claims to be examining greenfield sites carefully but has announced no plans for new construction. ALCOA feels expansion of supply is vital, but feels problems with assured supplies of energy in the United States are preventing the company from expanding primary capacity.

Only Alcan is undertaking a major primary plant construction. The plant is being built in Quebec. Hydroelectric power to support the facility is available from Alcan's own power plants. Thus, some industry leaders foresee a shortage of domestic primary aluminum capacity in the 80's. Smelters are being located in parts of the world where energy costs are relatively low. Alcan is expanding smelting capacity in Brazil. Alcoa is expanding capacity in Australia through its subsidiary Alcoa of Australia. Kaiser is also considering expansion in Australia through its affiliate Comalco. Only Alumax is expanding capacity in the United States. Alumax is 45 percent owned by Mitsui of Japan, and 25 percent of the output of the new plant will be bought by Mitsui.

Inadequate Returns

Part of the reason aluminum companies are not expanding primary production is the over-capacity that has existed in the industry in the past. The aluminum industry entered the 1970's with a major expansion program underway, coincidental with a downturn in the economy. The marketplace drove prices down and the aluminum industry had poor years in 1973 and 1975. Companies are determined not to invest in new plants on speculation.

Kaiser Aluminum feels that it must make 12 to 13 percent on invested capital in order to justify new investment. With very strong sales and earnings recently, Kaiser calculates that current returns are now adequate. Thus it can be expected that over time higher prices and greater returns will lead to new investment—but companies will not invest in so much capacity that the low-priced aluminum that existed in the 70's will be available again.

Increased Sales of Sheet

Domestic demand for aluminum was increasing markedly for sheet products but the 1979-1980 recession adversely affected this trend. The growth, which presumably will resume as the economy regains momentum, is largely due to high demand from the automobile, the can and aerospace industries. As a result, the sheet facilities in America's aluminum sheet plants have been working near capacity. Thus expansions in sheet capacity are under way at U.S. plants run by Alcan, at ALCOA, at Kaiser, and at Reynolds.

In addition, the high volume production facilities required by the aluminum industry are allowing some aluminum companies to install high-volume, efficient facilities for the first time. This may increase the competitiveness of aluminum.

Much of the capital spending taking place now in the aluminum industry can be traced to the automobile. Increases in sheet purchases has caused strains in various parts of the aluminum manufacturing process. Therefore, for specific companies one can identify a new foil feedstock plant or a new continuous casting line as indirect results of increased aluminum shipments to the auto industry.

* * * * *

Appendix F contains brief profiles of the aluminum companies listed in Table 5-1.

6. METAL CASTING INDUSTRY

The metal casting industry is the fifth largest manufacturing industry based on value added by manufacture as reported by the U.S. Department of Commerce. In recent years the industry has been undergoing a period of rapid change due to changing markets, changing technology, pollution requirements, and safety requirements.

6.1 TYPES OF CASTINGS USED BY THE AUTO INDUSTRY

The automotive foundry industry is segmented by processes and metals used in casting. The key grouping is usually by metal cast (see Figure 6-1).

6.1.1 Metals Used

The key automotive metals are gray iron, ductile iron, malleable iron, and aluminum.

Gray Iron

Gray iron is the oldest known form of iron for producing castings. Because of damping and lubricating capabilities, gray iron is used for producing engine blocks, machine tools, and similar products. Gray iron shipments in 1977 were approximately $12.5 million tons or 64 percent of all casting shipments (see Table 6-1).

Malleable Iron

Malleable iron is a cast alloy rendered tough and ductile by controlled heat conversion. It is more expensive than gray iron and is used in parts that require toughness and elasticity, such as brake parts, suspension parts, universal joints, yokes, and automatic transmission parts.

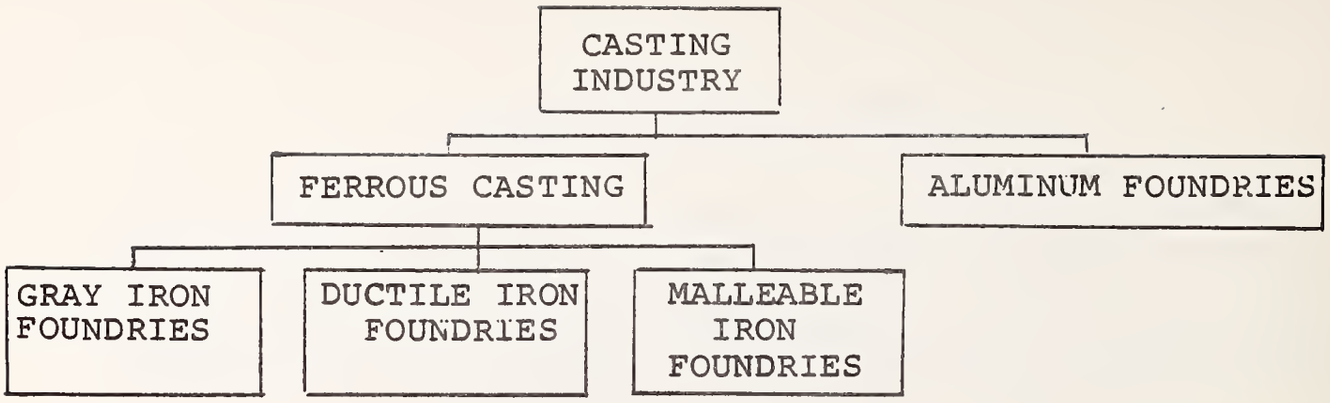


FIGURE 6-1. AUTOMOTIVE CASTING INDUSTRY SEGMENTED BY MAJOR METALS USED

TABLE 6-1. 1979 CASTING PRODUCTION

METAL	NET TONS (Millions)	PERCENT OF TOTAL (Rounded)
Gray Iron	11.9	64
Ductile Iron	2.7	15
Malleable	.7	4
Steel	2.0	11
Non ferrous	1.3	7
TOTAL	18.6	

Ductile Iron

Ductile iron castings are the newest form of iron casting and compete with malleable iron and cast steel. The ductile iron products are far more readily castable than steel and they exhibit strengths approaching cast steel. In addition the castings are more elastic than gray iron which is very brittle. While more expensive than gray iron, the ductile iron castings exhibit greater strength and can thus be cast on thinner, lighter sections. In addition, on applications where tough, ductile castings are required (as in brake parts), ductile iron can compete on cost and quality with malleable iron.

Aluminum

Aluminum is used in automobiles because it results in castings weighing roughly one-third of the same part cast in iron. However, the castings are generally four to five times more expensive than their iron counterparts. Thus aluminum castings have not been widely used until recently when the auto manufacturers began to lighten their cars to improve fuel economy.

6.1.2 Casting Processes

The key automotive casting processes are green sand molding, shell molding, permanent molding and die casting.

Green Sand Molding

Green sand molding is done by mixing a binder with sand and compacting it under pressure on a steel pattern. The process is used to produce a wide range of casting weights with good dimensional control. It is readily automated in certain casting ranges.

Shell Molding

Shell molding utilizes sand mixed with a resin which is heat-baked on a steel pattern. The process is used to manufacture small castings of high dimensional accuracy with an excellent surface finish for machining.

Permanent Mold Casting

Permanent molding is mainly used by the automotive industry for aluminum casting. The process employs metal molds and cores into which molten metal is poured. GM and Ford are using semi-permanent mold processes to produce aluminum intake manifolds.

Permanent mold castings have much lower tooling costs than die castings. With the permanent mold process intricate shapes can be obtained.

Die Casting

Die casting is expected to be a very important process in future high volume applications of aluminum in cars. In die casting, molten metal is forced into a die cavity under extreme pressure. The advantages of die casting include low finishing costs, high dimensional accuracy, and in high production quantities, lower costs than other casting processes.

There are two kinds of die casting processes: hot chamber and cold chamber. In the hot chamber process molten metal flows into an enclosed section where it is forced into the die cavity at pressures up to 2000 psi. Cold chamber die casting is similar but uses much higher pressures.

Cold chamber die casting is the predominant process. Aluminum cannot be practically hot chamber cast because of the solubility of ferrous materials in molten aluminum. However, hot chamber casting of magnesium is feasible and the process is highly efficient for production of small parts. There is currently considerable interest in this process and Ford is examining hot chamber magnesium possibilities carefully. The company currently uses a magnesium cast part in its tilt steering column assembly.

Magnesium is lighter than aluminum by about 30 percent, but the metal has traditionally been more expensive than aluminum. However, rising aluminum prices and improved magnesium fabrication technology may make magnesium attractive to the auto industry.

6.2 IMPORTANCE OF THE AUTO MARKET TO THE CASTING INDUSTRY

The automotive market is extremely important to the casting industry. The foundries that are part of General Motors, Ford, and Chrysler by themselves contain approximately 20 percent of the casting capacity of the entire industry. General Motors alone has hundreds of casting suppliers.

The automobile industry annually consumes approximately 25 percent of gray iron casting production, 65 percent of malleable iron casting production, 55 percent of ductile iron castings, and 55 percent of aluminum die casting production.

Typical applications of castings in the auto industry include:

- Engine blocks
- Cylinder heads
- Manifolds
- Brake parts
- Housings
- Yokes
- Transmission parts.

6.3 SIZE AND STRUCTURE OF THE CASTING INDUSTRY

In 1978 there were approximately 1,416 gray and ductile iron foundries, 56 malleable iron foundries, and 2,866 non-ferrous foundries. Ninety-three percent of these employed less than 250 people.

Foundries that are owned by corporations and make castings predominantly for that corporation are termed "captive" foundries. Foundries that supply to outside customers are termed "jobbing" foundries.

In the auto industry each of the major manufacturers own foundries. These foundries make high-volume parts. General Motors Corporation owns 24 foundries with a total annual capacity of 3.1 million tons. Ford Motor Company owns six foundries with a total 1.8 million ton capacity. Chrysler Corporation has five foundries capable of making .6 million tons of castings a year. General Motors is considered to have a greater in-house casting capacity relative to its needs than the other car manufacturers. However, all the car manufacturers have a large amount of castings done by jobbing foundries outside the auto industry. Estimates on the amount of automotive castings done by the jobbing foundries range from 20 to 50 percent of total automotive casting tonnage.

There are an estimated 550 to 600 jobbing foundries that have a considerable amount of business with the auto industry. Table 6-2 lists some of the largest foundries in the United States. Companies selected for study in this report represent the largest of the non-captive foundries as well as some of the smaller foundries known to be heavily dependent on the auto industry. In addition, Doehler-Jarvis, the nation's preeminent die caster, was also selected for study.

TABLE 6-2. MAJOR FOUNDRIES

COMPANY	MONTHLY IRON CASTING PRODUCTION UNITS	TYPE OF FOUNDRY	PERCENT TO AUTO INDUSTRY
General Motors Central Foundry	100,000	Captive	
Lynchburg Foundry	25,000		50
Dayton Malleable	22,500		More than 30
Deer & Company	22,000	Captive	
Wheland	20,000		90
CWC-Textron	17,000		25
Hayes-Albion	16,000		75
International Harvester	15,000	Captive	
Caterpillar Tractor	12,000	Captive	
Waupaca	12,000		
Brillion	8,800		
Neenah	8,500		
East Jordan Iron Works	6,600		
Eaton Corporation	6,500		
Auto Specialties	5,400		
Columbus	5,000		50

Source: Cast Metals Federation and Company Statistics.

6.4 MAJOR ISSUES FACING THE CASTING INDUSTRY

The casting industry is undergoing significant change. Tonnage shipped has remained relatively steady over the past ten years, yet the number of establishments has dropped significantly (see Table 6-3). The foundries that have gone out of business have mostly been small facilities unable to cope with changing technology or pollution and safety regulations. Many larger foundries have been expanded and modernized. The Department of Commerce and foundry industry spokesmen forecast continued growth in the castings market over the next five years.

TABLE 6-3. METAL CASTING GROWTH

YEAR	CASTING PRODUCTION* (Millions of Tons)	CASTING VALUE** (Billions of Dollars)
1968	19.5	11.2
1969	20.8	12.3
1970	18.0	11.3
1971	17.8	11.6
1972	19.6	13.8
1973	21.9	17.0
1974	20.2	17.8
1975	16.4	16.4
1976	18.4	20.2
1977	19.4	22.1
1978 (Estimate)	19.6	23.0

Source: * U.S. Bureau of the Census.

** Foundry Management and Technology Metal Casting Industry Census Guide, 1979.

Major issues currently confronting the casting industry include:

- Changing technology. The industry is increasing ductile iron production as a substitute to gray and malleable iron.
- Changing markets. The auto industry downsizing and lightening of cars is leading to smaller castings and changes from iron to aluminum castings.
- Competition from overseas.
- Capital shortages.

Changing Technology

The major auto manufacturers have increasingly switched to ductile iron for many of their parts. As a result, foundries with a capability in ductile iron have seen substantial growth in their business. Other foundries have been forced to buy the new equipment needed to produce ductile iron and to learn the technology and production methods needed to produce these castings. Malleable iron foundries have had a particular problem with this changing technology since ductile iron is in many cases the preferred substitute to malleable iron.

Changing Markets

Changes in the auto industry are having important impacts on the foundry industry. The conversion of certain auto parts to aluminum has caused a decrease in gray iron sales for some companies, especially those producing parts that have been converted to aluminum, such as intake manifolds.

The general downsizing of cars has caused a weakening of the casting market since smaller castings lead to increased capacity in the industry. Some companies have claimed that the captive auto foundries have taken a greater share of casting production to the detriment of the jobbing foundries. Other foundries, especially those that produce ductile iron or produce parts that have not been downsized or switched to aluminum, report no impact from auto industry changes. The entire foundry industry is estimated to currently be operating at 70 percent of rated capacity.*

* American Metal Market, April 21, 1978, page 6A.

It is still unclear what the ultimate effect of automobile downsizing will be on the casting industry. Industry spokesmen, such as Thomas Wiltse of General Motors Central Foundry Division, have suggested that both independent iron and aluminum foundries will see growth in the next five years. Other people close to the industry feel that these predictions are based on overly optimistic projections of automobile sales through the 80's. Automobile downsizing, it is felt, will cause considerable over-capacity in the gray iron foundry industry in the 1980's.

James Schultz, Detroit Manager of a major builder of foundries has suggested that automobile downsizing will accelerate the switch from gray and malleable iron to ductile iron: "You will see a changeover from gray to high ductile iron for the complete power train and undercarriage."* The ductile iron parts would be lighter due to the greater strength of the material.

There is a question whether the large captive foundries would assume a greater share of total auto foundry purchases if there was excess industry capacity due to auto downsizing. The captive foundries are large and tooled up for the components requiring high volumes. The jobber foundries tend to be more specialized and more susceptible to change. For instance, Dayton Malleable continues to sell automotive, air conditioning castings and CWC-Textron continues to sell camshafts to General Motors because the companies are able to produce the parts at less expense or with superior characteristics than GM's foundries.

Whether or not iron foundries have difficulties in the years ahead, aluminum foundries are expected to see considerable increases in business from the auto industry.

Competition From Overseas

Many foundries have found that some of their products are now being made overseas and sold at lower prices than the American foundries can charge. Castings are being imported from Japan, Brazil, and Europe. The castings are reportedly of good quality. Price has been cited as the principal reason for losing out to imports, even if quality had to be compromised. Although imports have affected the sales of foundries that serve the auto industry there have not been any reports of major auto companies purchasing castings from overseas.

---

* American Metal Market, April 21, 1978, page 3a.

Capital Shortage

A study by the Cast Metals Federation has indicated that due to predicted expansions, modernizations, and pollution abatement expenditures, the entire casting industry could need as much as $10 billion from 1978 through 1981 for capital expenditures. Further, 18 percent of the capital necessary will have to come from unknown sources.* The study indicates that low selling prices in the industry have resulted in inadequate returns to generate the capital needed. This is particularly a problem with smaller foundries.

* * * * *

Appendix G comprises brief profiles of the major foundries who supply castings to the automotive industry.

---

* American Metal Market, April 21, 1978, page 6A.

7. PLASTICS INDUSTRY

In recent years use of plastics in automobiles has been over 5 percent of total U.S. plastic consumption.* On the other hand, over 20 percent of U.S. steel production, over 10 percent of aluminum production and over 25 percent of U.S. casting production have been used by the automotive industry. Thus, in terms of share of the market, automobiles are relatively less important in the plastics industry than they are in the metal industries. However, the impact of changes in automobile design on the plastics industry will still be quite significant. Growth of plastics use in the automobile is expected to be quite large over the next decade, giving a vital contribution to the overall growth of plastics during this period. In addition, the growing use of plastics in the automobile is expected to particularly impact certain resins and processors, and changes in the automobile will have a magnified impact on the sections of the plastics industry dealing with these products or processes.

7.1 PLASTIC PRODUCTION

The production of plastic parts of the type used in automobiles requires two basic steps: resin production and plastic processing. Resin production involves the basic conversion of plastics from basic feedstocks to plastic materials (resins) in the form of granules, pellets, or powders. This step also usually involves compounding or formulating the base plastic into the finished plastic material by adding various chemicals. Processing refers to the steps required to turn the plastic material into secondary products (sheet, battery cases, hose, coated fabric, fascias).

7.1.1 Resin Production

The raw materials for the manufacture of plastic materials or resins are called intermediates or monomers, and are derived from natural gas, crude oil, or petroleum products. (See Figure 7-1. The major intermediates are ethylene, benzene, and

---

* Society of the Plastics Industry.

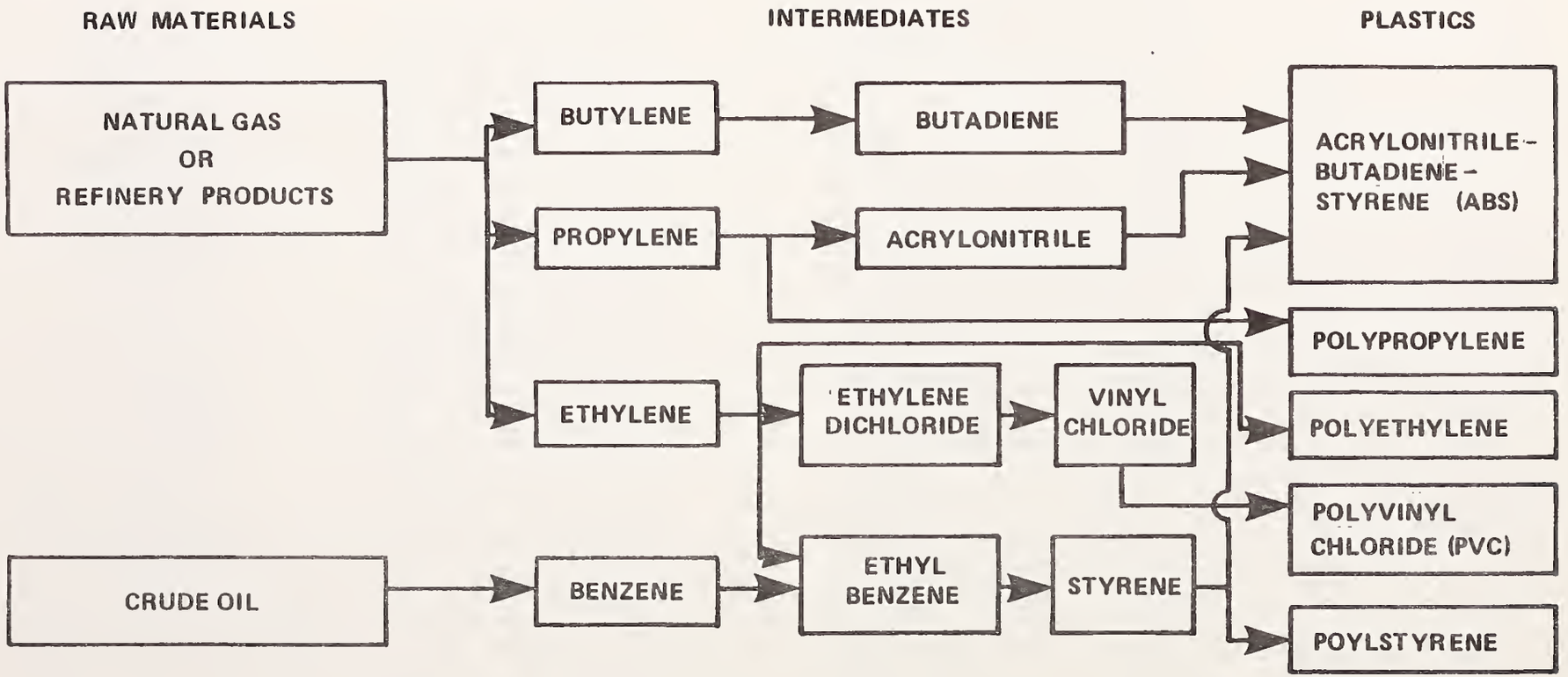


FIGURE 7-1. SIMPLIFIED DERIVATION OF SOME MAJOR AUTOMOTIVE PLASTICS

propylene. In the basic process of making plastics, called polymerization, simple monomers are joined together in large chains called polymers. A single type of repeating unit is called a homopolymer and a chain of two or more monomers is called a copolymer.

Modifiers, chemicals and additives are introduced into the plastic such as pigments for coloring, plasticizers to increase flexibility, stabilizers to make the product more resistant to heat and light, or fiber reinforcements to make the material stronger. This process is called compounding.

Two broad categories of plastic resins exist, thermosetting polymers and thermoplastic polymers.

- Thermosetting polymers, once polymerized or hardened, cannot be softened by heating without degrading the material. Thermosets are usually liquid mixtures or molding compounds which are "cured" or solidified with chemicals or heat.

- Thermoplastic materials can be repeatedly softened or hardened by heating and cooling. Usually, thermoplastic resins are purchased as pellets or granules that are softened by heat under pressure so they can be formed, then cooled and hardened into the final desired shape.

The largest selling plastic resins are polyethylene, polyvinyl chloride, polystyrene, and polypropylene. These four resins account for about 70 percent by weight of all resins sold in 1979.

7.1.2 Processing

In plastic processing, the basic material is usually melted (in the case of thermoplastics) and the plastic takes the shape of a cavity, die, or roll. Major processes used for automotive materials are described below.

- Injection molding—The plastic resin, usually in granular form, is fed into a heated cylinder and softened. It is then forced through a nozzle and into a relatively cool mold held under pressure until it cools and hardens. The mold opens and the part in solid form is removed. This process is used for many automotive components, such as battery cases and air conditioning ducts.

- Compression molding—This method, commonly used for thermosetting materials, involves the squeezing of plastic material into a desired shape by application of heat and pressure to the material on a mold. The heated mold is closed around the material and during this time the thermosetting material undergoes a chemical change which permanently hardens it.

- Calendering—Calendering is used to process thermoplastics into sheets. The plastic material is passed between a series of three or four large, heated, revolving rollers which squeeze the material between them into a sheet or film.

- Blow molding—This process is used for hollow plastic products such as gas tanks. Thermoplastic is melted and formed into a tube-like shape with sealed ends. Air is injected inside so that the tube expands and is forced against the walls of the mold. On cooling, the solidified plastic is ejected from the mold.

- Extrusion—Extrusion is used to form continuous sheeting, tubes or rods. Dry plastic material is melted and then forced out of a small opening or die with the shape of the finished product.

- Reaction injection molding (RIM)—This technique is primarily used for polyurethane parts such as bumpers or fascia. Two or more reactive streams are mixed together under high pressure and injected, under low pressure, into a mold. A reaction occurs and continues until the liquid becomes a cellular or solid product.

7.2 SIZE AND STRUCTURE OF THE PLASTICS INDUSTRY

The plastics industry is large and consists of a diverse group of resin producers and plastic processors.

7.2.1 Size of Industry

In 1979 total U.S. plastic production was over 35.2 billion pounds and the value of industry shipments was more than 14 billion.* Industrial chemicals are the third largest industry in terms of value added by manufacture and plastic resins account for about 14 percent of the industry's shipments. The plastics industry employs over 460,000 people.

---

* 1980 U.S. Industrial Outlook.

7.2.2 Industry Structure

For the most part, the plastics industry is divided into two broad sectors—the resin producers and the plastic processors.

Resin Producers

The resin producers make the basic plastic materials from feedstocks. These companies also usually do any required plastic compounding or mixing. The resin producers tend to be very large chemical and oil companies and usually specialize in just a few types of plastics. Table 7-1 shows some of the largest plastic resin companies and indicates sales and some of the major plastics produced. Many of the resin companies also do processing or fabricating. Even though plastics is a capital-intensive industry, resin production is not highly concentrated.

TABLE 7-1. LARGEST PLASTIC COMPANIES

Company	Plastic Sales ($ Millions)	Major Plastics
Dow Chemical	2,150	Polyethylene, ABS
DuPont	2,075	Polyethylene, engineering plastics
Monsanto	1,100	ABS
Union Carbide	975	Polyethylene, polyurethane, PVC
Dart	775	Polypropylene
B.F. Goodrich	450	PVC
Hercules	425	Polypropylene
Phillips Petroleum	400	Polyethylene
Ethyl	375	PVC

Source: Society of the Plastics Industry; 1977 data.

Note: Dollars are rounded to nearest $25 million and include fabricated products.

Processors

Plastic processors fall into three rather diverse categories:

- Resin producers—Many of the large resin producers process a portion of their plastics and make such products as film, textiles, or calendered plastics. In the auto industry this situation occurs for parts like vinyl seat covers or urethane foam seats but is much less likely to be found in specialized plastic automotive parts like bumpers or grilles. Approximately 20 percent of resin production is processed within the producers' own companies.

- Processors captive to end users—Many end users have their own captive shops that make plastic parts. Industries that process plastics for their own use include the automotive, communications, film, packaging, pipe, appliance, and recording industries. Approximately 50 percent of resin production is processed by captive shops.

- Independent plastic processors—Independent processors purchase resin and manufacture plastic parts which are sold to other companies. This industry is very fragmented, consisting of many companies of varying sizes. The approximately 5,550 custom or independent processing plants process about 30 percent of resin production.

Major processing plants are listed in Table 7-2.

7.3 THE AUTOMOBILE AND THE PLASTICS INDUSTRY

The automotive industry uses over 5 percent of plastic production, and this figure is expected to increase in the next ten years.

7.3.1 Types of Plastics Used in Cars

Table 7-3 lists the major plastics used in automobiles in 1978 and 1979. The most important automotive plastics are polyurethane, reinforced polyester, polypropylene, polyvinyl chloride, and ABS. This list differs in some important ways from the top four plastics for all markets (polyethylene, polyvinyl chloride, polystyrene and polypropylene). Polyethylene and polystyrene are not particularly important for automotive use, whereas polyurethane and reinforced polyester

TABLE 7-2. MAJOR PROCESSING PLANTS PRODUCING OVER 100 MILLION POUNDS PER YEAR

Company Name and Location	Principal Plastics	Principal Processes	Principal Product
Acushnet Co., New Bedford, MA	PUR	Casting	Industrial
Crown Zellerbach Corp., Orange, TX	LDPE	Extrusion-film	Packaging
Davidson Rubber Co., Dover, NH	PUR	Reaction injection	Automotive
DuPont Co., Richmond, VA	TPP	Extrusion	Packaging
Eastman Kodak Co., Rochester, NY	PS	Injection molding	Cameras
Ethyl Corp., La Grange, GA	LDPE	Extrusion-film	Packaging
Exxon/Extrudo, Pottsville, PA	LDPE,PP	Extrusion-film	Packaging
Firestone Tire & Rubber Co., Pottstown, PA	PVC	Extrusion	Packaging
General Electric Co., Louisville, KY	PS,PP	Injection molding	Appliances
General Motors Corp., Delco Remy, Anderson, IN	PMMA,PP	Injection molding	Automotive
General Motors Corp., Packard Electric, Warren, OH	PP,PS	Injection molding	Automotive
General Motors Corp., Saginaw Steering, Saginaw, MI	PP,PS	Injection molding	Automotive
General Tire & Rubber Co., Ada, OK	PUR,PVC	Injection molding	Automotive
Grace, W.R., Co., Cryovac Div., Duncan, SC	PVC	Extrusion-film	Packaging
3M Corp., St. Paul, MN	TPP	Extrusion	Tapes/seals
Mobil Chemical Co., Macedon, NY	LDPE	Extrusion-film	Packaging
Presto Products Inc., Appleton, WI	LDPE	Extrusion-film	Packaging
St. Regis Paper Co., Hazleton, PA	LDPE	Extrusion-film	Packaging
Tupperware Co./Dart, Providence, RI	HDPE	Injection molding	Housewares
Tupperware Co./Dart, Hemingway, SC	HDPE	Injection molding	Housewares
Tupperware Co./Dart, Jerome, ID	HDPE	Injection molding	Housewares
Tupperware Co./Dart, Halls, TN	HDPE	Injection molding	Housewares
Union Carbide Corp., Rogers, AR	LDPE	Extrusion-film	Packaging
Western Electric Corp., Atlanta, GA	HDPE	Extrusion	Wire/cable

Abbreviations for plastics:

ABS	Acrylonitrile-butadiene-styrene	HDPE	High-density polyethylene	TPP	Thermoplastic polyester
POM	Acetal	HIPS	High-impact polystyrene	PF	Phenolic
PMMA	Acrylic	LDPE	Low-density polyethylene	UP	Thermoset polyester
CA	Cellulose acetate	PA	Nylon	PP	Polypropylene
		PE	Polyethylene	PS	Polystyrene
		PUR	Polyurethane	PVC	Polyvinyl chloride

Source: Plastics World, January, 1979.

are of major importance. As automobiles are downsized, all those major plastics presently used in cars are contenders for increased usage, as are others such as polyethylene. In addition, engineering plastics, a group of plastics noted for their high strength and ability to be used in engineering applications, are likely to be important as downsizing continues. The most important automotive plastics, and engineering plastics, are discussed below.

TABLE 7-3. PLASTICS IN PASSENGER CARS IN 1978 and 1979 (000 TONS)

Material	1978	1979
ABS	70	70
Acrylic	20	21
Nylon	24	25
Phenolic	23	24
Polypropylene	150	160
Polyurethane	170	185
Polyvinyl chloride	130	128
Reinforced polyester	160	180
Other	40	41
TOTAL	787	834

Source: Modern Plastics, January 1979.

Polyurethane

Polyurethanes are important in automobiles for use in seat cushioning, bumpers and fascias. Flexible foams are polyurethane materials that are flexible and resilient and can be used for seat cushions or other padding. Semirigid foams have less resilience and are finding applications in bumpers and fascias. Rigid foams have the potential to be used in many automobile parts, including exteriors. Urethanes are made from precursors called polyols and isocyanates. The types and mixture of these chemicals determine the properties the urethanes will have. The reaction injection molding process has recently become widely accepted for molding urethane foams, especially semirigid foams used in automotive front ends. Approximately 22 percent of the polyurethane foam consumed in 1979 was used in cars.

Reinforced Polyester

Reinforced polyester refers to a composite of thermosetting polyester plastic and, in most cases, glass reinforcing materials called fiberglass. The reinforced plastic is strong, can be used in various engineering applications and has exceptional strength to weight. Automotive uses include front fascia, spoilers, grille opening panels, fender skirts, and side rails. Reinforced plastic parts often come as mixed components such as sheet molding compound (SMC), a roll of thick sheet, or bulk molding compound (BMC), a slab of extruded log or rope. A common processing method used is press or compression molding where the materials (SMC, BMC, etc.) are placed in matched metal dies and pressed into shape. Automobiles accounted for over 20 percent of 1978 reinforced polyester consumption.

Polypropylene

Polypropylene is a thermoplastic found in many under-the-hood parts such as ducts, battery cases and fan shrouds. In some cases it is also glass reinforced. Polypropylene automotive parts, generally injection molded, accounted for 9 percent of total polypropylene consumption in 1979. The plastic can also be extruded into fibers, used in automotive carpeting.

Polyvinyl Chloride

Polyvinyl chloride (PVC), or vinyl, has exceptional chemical, weathering and abrasion resistance. The plastic is often processed by calendering and used for automotive upholstery. PVC is also used for vinyl roofs and for certain molded parts. In 1979 autos accounted for about 5 percent of PVC consumption.

ABS

ABS is known as both a commodity plastic and an engineering plastic depending on the specific formulation. This thermoplastic possesses outstanding impact strength and high mechanical strength. In automobiles it is used in grilles, lamp housings and instrument panels. Medium and high heat grades of ABS are used for many automotive components which are usually injection molded. Autos accounted for about 12 percent of ABS consumption in 1979.

Engineering Plastics

The engineering plastics are generally low-volume, high-priced plastics with relatively few suppliers. The transportation industry accounts for over 25 percent of the consumption of these materials. The major automotive engineering plastics are nylon, polycarbonates (PC), polyphenylene oxide (PPO) and polybutylene terephthalate (PBT). In 1976 automobiles accounted for 31 percent of nylon consumption, 7 percent of PC consumption, 42 percent of PPO consumption and 46 percent of PBT consumption.

Nylon is a strong tough plastic and is usually injection molded for vehicle parts such as fender extensions or master brake reservoirs. Nylon in fiber form can also be used in seat belt webbing, upholstery and carpeting.

Polycarbonates are tough, rigid and easily fabricated. However, they have poor resistance to marring, abrasion and solvents. The plastic is used in automotive front-end panels, rear lenses, and headlamp covers.

Polybutylene terephthalate, a thermoplastic polyester is very strong and has good electrical properties. It is used for exterior and interior automotive applications such as electronic ignition components and backup lights.

Polyphenylene oxide has high impact strength and is easily processed by injection molding. It is used in wheel covers, windshield wiper assemblies, and side window frames.

7.3.2 Suppliers of Major Automotive Plastics

Suppliers of the major automotive plastic resins are shown in Table 7-4 along with the capacities of these companies for the various plastics. Table 7-5 shows the major suppliers of engineering plastics and their capacities in millions of dollars. Companies that are the largest producers of these automotive plastics were selected for study in this report. The companies selected are shown in Table 7-6 along with their capacity ranking for the plastics. The largest suppliers of ABS are Borg-Warner and Monsanto. The largest suppliers of polypropylene are Hercules and Amoco. Polyurethane production is led by Union Carbide and Mobay, and B.F. Goodrich is the leading producer of PVC. The major producers of automotive engineering plastics are General Electric and DuPont and the leading fiberglass companies, who are also major producers of the unsaturated polyester used in reinforced plastics,

TABLE 7-4. CAPACITIES OF THE LARGEST SUPPLIERS OF MAJOR AUTOMOTIVE PLASTIC RESINS

Plastic Resin	Supplier	Capacity (Millions of Pounds)
Polyurethane*		
Polyols	Union Carbide	598
	Dow Chemical	396
	Mobay	275
	Olin	253
Isocyanates	Mobay	385
	Upjohn	279
	ARCO	220
	Olin	220
Thermosetting Polyester*	Reichhold	352
	W.R. Grace	253
	Ashland	176
	PPG	154
	Owens-Corning	100
Polypropylene**	Hercules	1040
	Amoco	500 (720 in Nov. 1979)
	Shell	550
	Exxon	480
Polyvinyl Chloride**	B.F. Goodrich	1,050
	Tenneco	680
	Diamond Shamrock	520
	Conoco	510
ABS**	Borg-Warner	480
	Monsanto	460
	Dow Chemical	270
	USS Chemicals	210

Sources: Modern Plastics, Society of the Plastics Industry, and The Kline Guide to the Plastics Industry.

* 1976.
** 1978.

are PPG and Owens-Corning. (PPG and Owens-Corning are included in the glass section of this report.)

Many of the resin companies are also plastics processors, as is Libbey-Owens-Ford, a company covered in the glass section of this report. This report also covers two other major independent processors: Davidson Rubber (part of Ex-Cell-O) and General Tire. These two companies operate some of the largest independent processing plants that serve the auto industry.

TABLE 7-5. CAPACITIES OF THE LARGEST SUPPLIERS OF ENGINEERING PLASTICS

Supplier	Capacity (Millions of Dollars)				
	Nylon	PC	PPO	PBT	Total
General Electric	---	$110	$90	$17	$217
DuPont	$123	---	---	---	123
Mobay	---	33	---	---	33
Celanese	16	---	---	11	27

Sources: Modern Plastics, Society of the Plastics Industry, and The Kline Guide to the Plastics Industry.

7.4 KEY ISSUES

Several issues currently confront the plastics industry. These include:

- Low profits
- New markets
- Environmental and energy concerns.

7.4.1 Low Profits

Much of the plastics industry produces commodity or tonnage plastics characterized by very large volumes and indistinguishability of product. Thus many companies in the industry tend to compete on the basis of price. In recent years the plastics industry has been faced with the situation of overcapacity and low prices. Rates of return for plastics companies have been low.

TABLE 7-6. COMPANIES COVERED IN THIS REPORT AND CAPACITY RANKING FOR IMPORTANT AUTOMOTIVE PLASTICS

Supplier	ABS	Poly-propylene	Poly-urethane	PVC	Reinforced Plastic	Engineering Plastics	Processing
Monsanto	2					6	
Borg-Warner	1						*
Union Carbide			1	10			
Mobay			1			3	
Hercules		1					
Amoco		2					*
B.F. Goodrich	5			1			
DuPont			6			1	*
General Electric						1	*
General Tire				16			*
Davidson							*
PPG					*		*
Owens-Corning			7		*		
Libbey-Owens-Ford							*

* No ranking is available.

As a result, many companies, such as Hercules, are attempting to switch their product mix toward higher value products. The specialization of products can insulate the companies from downward pressure on price.

In the next decade capacities are expected to be much tighter as demand catches up with supply and construction of new capacity proceeds at a slower rate. Thus, prices are expected to improve over the next few years.

7.4.2 New Markets

Use of plastics has been growing faster than the overall economy and this trend is expected to continue. New markets are emerging for plastic companies, such as lightweight automotive components, structural components, and new insulation markets. The plastics industry increasingly is formulating specialized plastics that will meet the needs of particular market segments.

For the automobile, particular plastics are competing with metals and with other plastics to create lighter vehicles. The changes that are taking place in the automobile have forced the auto companies to look for new materials and processing methods. Thus, plastics companies with strong research and development capabilities have an advantage in capturing the growing automotive plastics market. Hercules is hopeful that a polypropylene-metal system it has developed will be used by Detroit. DuPont and General Electric are aggressively pushing new engineering plastics. Major producers of graphite fiber parts for the aerospace industry, such as Union Carbide and Hercules, are trying to develop the graphite-reinforcement market in Detroit. Plastics processors are working with the auto companies to develop new parts that can be made out of plastic. For instance, PPG has developed a plastic gas tank and works closely with General Motors engineers.

Companies with existing markets in the automotive industry are also seeking to preserve their position. General Tire, for one, has as a high priority the production of vinyl upholstery with less weight than current products.

Growth for most plastics in the auto industry seems assured to some degree. Not only is plastics usage expected to increase in each car, but the number of cars manufactured each year is supposed to increase significantly over the next few years. However, right now the best plastic growth prospects seem to be for polyurethanes and reinforced plastics. These plastics have the potential for replacing major parts of cars—such as body parts and engine parts. If either of these materials succeeds in becoming widely used as a replacement for sheet metal parts, volumes purchased would be quite large. Key companies to watch, therefore, are Union Carbide, Mobay, PPG, and Owens-Corning.

7.4.3 Environmental and Energy Concerns

The chemical industry has been affected by several environmental regulations regarding the quality of the chemical environment of company plants and with the toxicity of the chemicals produced. The Government has required all chemical companies to list the chemicals they produce, where they are produced and in what volume. Concern exists about the effect of these chemicals on workers, on the environment and on consumers. The Food and Drug Administration also is looking carefully at the effect of plastic packaging on food.

These various investigations by the Government and other groups have increased the importance of testing and toxicology within the plastics industry.

Concern has also been raised about the effects of plastics in waste disposal systems such as dumps or sanitary landfills. The plastics industry emphasizes that the use of plastics in sanitary landfills creates a stable nonsettling base, and that this helps make the land more quickly recoverable.

Finally, since plastics are derived from petroleum products, the country's current energy problems significantly affect the plastics industry. It is not likely that rising oil prices will make plastic less competitive versus other materials, such as steel. In many cases, plastics actually use less total energy to manufacture, including the energy in the feedstock, than competing materials. Rising oil prices

will affect the relative importance of raw material prices in the petrochemical industry. Eventually, rising oil prices may lead to a switch to coal as the basic feedstock, and this would cause considerable changes in the industry. Already the shortages of natural gas have led plastics companies to increase their dependence on refinery products for raw materials. This trend is expected to continue.

* * * * *

Appendix H comprises brief profiles of the major suppliers of plastics designated earlier in Table 7-6.

8. THE GLASS AND FIBERGLASS INDUSTRY

The glass industry is usually divided into at least two sections: flat glass, which is used in mirrors and windows; and glass bottles and decorative glass, used for packaging and decoration. The automotive industry is not important in the latter market, but extremely important in the flat glass market. Automobiles consume nearly 30 percent of domestic flat glass production and have a tremendous influence on the business of their major suppliers.

Fiberglass is a relatively new product, first produced on a large scale about 40 years ago. It is basically glass drawn into tiny, hairlike fibers. The major uses of fiberglass are for textile products, thermal insulation and reinforcements. In the automobile, fiberglass is used as reinforcing material usually for thermosetting polyester resin, the combination called fiberglass-reinforced plastic or FRP. Major fiberglass companies also produce polyester resin and they use the two products to market FRP materials under such names as sheet molding compound (SMC). Automobiles presently consume approximately 10 percent of U.S. fiberglass production.

8.1 THE GLASSMAKING PROCESS

Glass is basically the result of fusing together, under great heat, silica sand, soda ash, limestone, salt cake, and certain other ingredients. As shown in Figure 8-1, three basic steps are involved in manufacturing finished glass products:

- Mining—This step involves extracting from the earth those raw materials needed to make glass. In most cases, the nation's glass makers obtain their sand, soda, ash, limestone, dolomite and salt cake from outside suppliers, who normally ship these materials to the glass makers' manufacturing plants.

- Processing (Glassmaking)—This step involves converting the raw materials, plus scrap, into the primary product, which is either flat glass or glass fiber.

- Fabricating—This step involves converting the primary product into various finished configurations such as laminated safety glass, industrial and residential window glass, and glass fibers in finished form or woven into insulation batting.

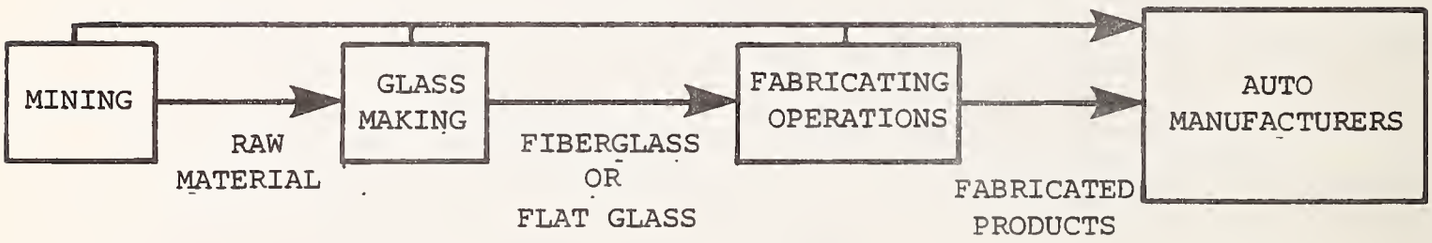


FIGURE 8-1. STEPS IN GLASSMAKING

The following two sections describe the methods used to process (manufacture) flat glass and fiberglass.

8.1.1 Manufacturing Flat Glass

Today, flat glass manufacture is highly mechanized and automated, and far from the laborious, time-consuming and expensive glassmaking processes that prevailed until modern manufacturing procedures began to be utilized around 1920.

Sheet and Plate Glass Process

Around 1920, processes were developed to mix the molten glassmaking materials in a giant furnace, then pull the mixture along a series of rollers to produce glass. This process vastly improved the consistency and quality of glass produced, reduced the cost dramatically, and prevailed for more than 30 years. The product that resulted from this manufacturing process, called sheet glass, was clear and smooth, but the surface was not perfectly level. Thus, sheet glass was useful for windows but the product could not be used for good mirrors or display cases where a high quality surface was mandatory. High quality glass, called plate glass, was made by taking sheet glass and putting it through a lengthy

and expensive grinding process that yielded a polished, level surface. Plate glass was expensive and used only where clarity was essential.

Float Glass Process

Approximately two decades ago, the float glass process was perfected and quickly began replacing the sheet-rolled glassmaking process throughout the industry. Today the float glass process is used for making almost all automotive glass. Instead of rolling the molten glass, which resulted in the need for extensive grinding and polishing to produce a bright, clear surface, the float process feeds molten glass onto the top of a bath of molten tin. Controlled heating permits the glass to flow to form a flat ribbon of uniformly thick glass. Near the end of the bath, the glass is slowly cooled or annealed. Because glass becomes stiff enough to be transported onto rollers at a temperature above the melting point of tin, the glass can be fed off the still-molten tin in a continuous sheet. The thickness of the glass is controlled by changing the speed at which the ribbon of glass is moved into the annealing "lehr" (cooling area). The glass that comes off the line in this process requires no grinding or polishing. Thus, float glass has the quality of plate glass at much less cost.

8.1.2 Manufacturing Fiberglass

To make fiberglass, the basic ingredients for making glass are mixed and melted at a high temperature. Fine, precisely controlled filaments are drawn rapidly from streams of molten glass. These filaments may be sized and then wound on packages for further fabrication.

There are two basic forms of glass fiber:

- Continuous filament fiberglass, which is composed of very long, continuous fibers drawn from molten glass at speeds in excess of two miles per minute

- Staple filament fiberglass, which is an individual fiber 8 to 15 inches long. It is formed by jets of air which pull the glass filaments from the molten glass streams onto a revolving vacuum drum.

Both continuous filaments and staple filaments are wound into lengths of fiberglass called strands.

8.2 SIZE AND STRUCTURE OF THE DOMESTIC FLAT GLASS AND FIBERGLASS INDUSTRY

The domestic flat glass and fiberglass industry is made up of less than 20 companies and dominated by three—PPG, Libbey-Owens-Ford (LOF), and Owens-Corning.

8.2.1 Size of the Industry

The domestic flat glass industry employed more than 24,500 workers in 1979, and recorded overall sales of $2.1 billion. The fiberglass segment of the industry employed an additional 25,000 and recorded sales of over $2.0 billion in 1978.

8.2.2 Industry Structure

In general, glass and fiberglass companies perform both glass manufacturing and glass fabrication, even though the facilities for the two processes are often separate. The companies, however, are not generally integrated into mining. The total glass industry is separated to a large extent in terms of glass product. Companies that make jars and glasses use a different manufacturing process than flat glass manufacturers and they usually do not make flat glass. The flat glass industry is also separate from the fiberglass industry, although in certain cases companies make both products.

Flat Glass Segment

More than 90 percent of all flat glass manufactured in this country is produced by six companies: PPG, Libbey-Owens-Ford; ASG Industries, Inc.; Ford Motor Company; Guardian Industries, Inc.; and Combustion Engineering Corporation. As shown in Table 8-1, PPG (formerly Pittsburgh Plate Glass), is the country's largest flat glass maker. Libbey-Owens-Ford is second largest, and Ford is third. Together these three companies account for about 81 percent of flat glass production.

As can be seen from the table, considerable changes in market share have been taking place in recent years. This has been largely due to the complete replacement of sheet and plate facilities with float glass plants. Since PPG introduced float glass into the United States in 1963 under a Pilkington license, the flat glass industry has rebuilt nearly its entire productive capacity. PPG's market share has declined from 41 percent in 1971 to 34 percent in 1978, whereas Ford's has risen from 13 percent to 19 percent as old plants were closed and expansion by smaller companies became possible.

TABLE 8-1. FLAT GLASS MARKET SHARES (PERCENTAGE BASED ON CAPACITY)

Company	1971	1973	1975	1977	1979E
PPG Industries	41%	38%	36%	34%	34%
Libbey-Owens-Ford	30	29	28	28	28
Ford	13	14	18	19	19
Guardian Industries	3	5	6	7	9
ASG Industries	8	8	6	6	5
C-E Glass	1	3	3	3	3
Fourco	4	3	3	3	3*
TOTAL	100%	100%	100%	100%	100%

* Includes operations sold in 1977.

Source: U.S. Glass, Metal & Glazing, January 1978.

Fiberglass Segment

The fiberglass segment of the industry operates nearly 100 plants and shipped approximately two billion pounds of glass fibers in 1978. This segment is dominated by one firm, Owens-Corning Fiberglas Corporation. Other major firms in this industry are PPG, Certainteed Corporation and Johns-Manville Corporation. Owens-Corning and PPG are the predominant suppliers of automotive fiberglass reinforcement. Owens-Corning is also the largest producer of fiberglass insulation, with Certainteed and Johns-Manville the other major producers of this product.

8.3 GLASS AND THE AUTOMOTIVE INDUSTRY

As shown in Table 8-2, automotive sales are highly important to domestic flat glass makers, accounting for approximately 30 percent of their total sales. Automotive applications consume approximately 10 percent of fiberglass sales, but this percentage is growing.

Libbey-Owens-Ford (LOF) is the largest automotive glass producer and PPG is the second largest. Typically, GM's business is divided 72 percent-28 percent between Libbey-Owens-Ford and PPG, respectively. Ford supplies much of its needs internally, and Chrysler obtains its raw glass requirements from PPG and LOF. Libbey-Owens-Ford currently supplies two-thirds of all glass consumed by General Motors—the firm formerly supplied all of GM's glass. Libbey-Owens-Ford is thus highly vulnerable to the uncertainties of GM's automotive production.

Detailed information is not available on the fiberglass industry. However, both PPG and Owens-Corning are known to be major suppliers of fiberglass for automotive products.

Principal automotive glass products are laminated safety glass, tempered safety glass and various fiberglass reinforcing products.

TABLE 8-2. ESTIMATED FLAT GLASS CONSUMPTION BY MARKET* (ESTIMATED FOR 1979)

Market	Millions of Square Feet	Percent of Total
Cars	640	20.0
Trucks	210	6.5
Total Automotive	850	26.5
Automotive Replacement	210	6.6
Residential Construction	1,250	39.1
Nonresidential Construction	410	12.8
Other**	480	15.0
Total	3,200	100.0

Source: U.S. Glass, Metal & Glazing, January, 1978.

* Excludes imports.

** Includes mirrors, industrial, export, manufactured inventories, etc.

8.3.1 Laminated Safety Glass

Laminated safety glass is used in automobile windshields. The product, introduced in the late twenties, is basically composed of two plies of float glass with a layer of plastic between them. Large "autoclaves," which operate much like massive pressure cookers, permanently bond the two plies of glass to the plastic interlayer. The interlayer conforms to the surfaces of the glass under heat and pressure, and becomes transparent in the process.

Various types of interlayer are currently in use, with highly penetration-resistant plastics in use throughout the industry for windshields. This gives the windshield greater "stretch" potential and reduces the chance of serious injury in accidents.

8.3.2 Tempered Safety Glass

Tempered glass is widely used for automotive side and back windows. The basic product is made by heating float glass until it is almost plastic and cooling it suddenly by subjecting the surfaces to jets of air. Both outer surfaces, cooling more rapidly, are in a state of compression while the inner portion of the glass is in tension. This makes the glass three to five times as strong as regular annealed glass and also more resistant to impact shock from blunt objects. It offers a high degree of resistance to breakage and when fractured disintegrates into small fragments.

8.3.3 Fiberglass Products

Fiberglass for reinforcing is available in several forms. Continuous strand glass gives unidirectional reinforcement whereas glass woven into fabric reinforces the object in two directions. Chopped glass strands and reinforcing glass mats give random reinforcement. Fiberglass is often marketed in the form of compounds with thermosetting polyester for the molding of plastic parts.

Basic automotive fiberglass applications include tire cord and belts; and reinforcement for numerous plastics utilized in everything from the Corvette body to various front-end, engine, and drive train components.

8.4 MAJOR ISSUES AFFECTING THE GLASS INDUSTRY

Although the country's major glass and fiberglass producers are basically healthy, several key issues are causing the exertion of considerable effort in these corporations' marketing, product planning and production departments. The major issues impacting the glass makers and fiberglass producers are:

- The downsizing of the American automobile and resultant use of less glass per car
- Cyclical nature of the housing and construction industry, as well as the automotive industry
- The impact of the energy crisis on production and markets.

8.4.1 Downsizing

As Detroit struggles to make cars which are smaller and weigh less, glass is inevitably affected. Smaller cars theoretically use less glass, and lighter cars need lighter glass. The result has been a scramble by the glassmakers to produce lighter and stronger glass, which often requires extra fabricating and finishing to produce. The net effect has been a healthy one—at least so far—with the glassmakers realizing greater profits from the value-added effort they exert before shipping their product to the automotive community.

The future of automotive glass usage, however, is still a potential problem for the glass industry. The use of value-added and highly styled glass has already occurred and cars are still getting smaller. Glass makers hope that automotive designers may resort more to styled glass products as they attempt to differentiate small cars that are otherwise restricted in design, weight and roominess. This trend could increase profits per square foot of glass.

Fiberglass companies should continue to benefit from automotive downsizing. The future of fiberglass use in cars is still dependent on the successful introduction of products that can reduce the cost of fiberglass parts and improve their surface finish.

8.4.2 Cuclical Nature of Major Markets

Since the glass companies negotiate automotive glass production contracts before the model year begins, if auto sales are poor the glass companies have no capability of changing their share of the auto market. Thus, unused capacity must be shifted to other markets, primarily the residential glass market. Drops in auto production lead to a significant impact on supply and prices in the construction market.

In addition, construction is also a highly cyclical market. Glass sales are dependent on both residential housing completions and nonresidential construction. Therefore, the flat glass industry is particularly cyclical, and as a result certain companies have attempted to diversify their product base.

8.4.3 Impact of the Energy Crisis

Rapidly increasing costs of energy—especially natural gas and fuel oil—have been felt acutely by the nation's glassmakers, and are a cause of continuing concern. The industry as a whole has attacked the problem vigorously by instituting energy-conserving production procedures. (The float glass process is more energy-efficient than the sheet glass roller process.) The industry is concerned as much with the availability of sufficient energy resources as with the cost. Several companies have modified their production equipment for dual-fuel capability, and several are actively pursuing the development of company-owned natural gas and oil reserves. The nature of the glassmaking process does not lend itself to the use of coal for fueling its furnaces, precluding a shift to this abundant national energy resource.

In addition, the energy crisis has stimulated demand for glass. The use of insulated glass has increased dramatically over the past five years, as has the use of reflective glass and other coated glass products.

The growing demand for fiberglass insulation is straining the insulation manufacturing capacities of the entire fiberglass industry—both a blessing and a dilemma. If the industry expands its insulation capacity significantly to meet the booming demand (much of which is for insulating existing homes), it fears heavy overcapacity within five years or so when most of the nation's homeowners will have insulated their homes as much as they are going to. So the industry will probably struggle to meet current demand without extensive insulation capacity expansion.

* * * * *

Appendix I consists of one-page summary profiles of the three dominant glass and fiberglass suppliers--PPG Libbey-Owens-Ford, and Owens-Corning.

APPENDIX A

SUMMARY PROFILES OF NORTH AMERICAN PARTS AND COMPONENTS SUPPLIERS

A. O. SMITH

A. O. Smith was founded in 1874, is a family-controlled company and is the world's largest independent manufacturer of automotive, truck, bus and trailer frames, producing approximately four million frames annually.

A. O. Smith's 1979 sales were $.84 billion, about 50 percent higher than in 1974. The Automotive Division accounts for over one-half of the total. (Over 50 percent of automotive sales are to General Motors.) The company employs 12,700 people, with three major automotive facilities in Wisccnsin, Illinois and Tennessee. The company is organized into product divisions, the largest being the Automotive Division, which in addition to frames, makes other automobile structural parts and bumper reinforcements.

The frame business is tied directly to new vehicle markets and is reduced by vehicle downsizing, since small front-wheel-drive cars typically use a unibody, not body-on-frame structural design. A. O. Smith recently announced that by 1983 it expects a decline of up to 75 percent in its sales of passenger car frames. The company hopes to partially offset this loss through sales of new products, such as rear axles. In 1980, the company is also attempting to further diversify its operations. Substantial engineering efforts have been expended on weight/cost reduction designs for automobile frames for demonstration to General Motors. A. O. Smith will continue to supply frames for light trucks and other applications.

A. O. Smith's earnings have remained strong with a record 14 percent return on equity in 1979. Earnings amounted to 3.5 percent of sales. Despite recent increases in capital expenditures to 10.3 percent of assets in 1979, long-term debt has been declining as a percent of capitalization in the last five years and in 1979 was only 14 percent.

ARVIN INDUSTRIES

Arvin's 1979 sales were $493 million. Sales grew at a rapid pace in the mid-seventies but have slowed in recent years. Approximately 66 percent of sales and 72 percent of the profits are in the automotive market. The two largest domestic automotive manufacturers account for about 47 percent of sales. The company employs 8,500 people.

Arvin has a decentralized structure with a variety of businesses organized into an Applied Technology Group, Metals Group, Consumer Group and Automotive Group. Major automotive products include mufflers, exhaust and tailpipes, coated steel and, introduced in the mid-70's, catalytic converters. The introduction of catalytic converters significantly boosted Arvin's sales. Arvin feels that increasingly its products are designed primarily to meet government regulations dealing with pollution, noise and mileage standards and therefore it must excel in new product design and quality control. Arvin has begun to enlarge its technology with a new Automotive Technical Center (1978) and the acquisition of CALSPAN Corporation, a major auto safety research firm.

Arvin's return on equity jumped from 6.6 percent to 26 percent in 1976, but is now down to 12.8 percent. In 1979 the company's earnings were 4.1 percent of sales. Arvin has been decreasing its debt to improve its financial rating. Its debt as a percentage of capitalization has been decreased from 43.2 percent in 1976 to 32.1 percent in 1979.

Arvin has seven of its 17 facilities (60 percent of space) dedicated almost totally to production of OEM components. Plants are located primarily in Indiana and states to the south. Arvin's recent capital expenditures have been running at an average of 8 percent of total costs per year. Projects include new catalytic converter manufacturing systems, expansion of zinc-coated steel production and a joint venture with Eluma S/A in Brazil to produce exhaust systems for the Brazilian market.

CHAMPION

Champion is the largest spark plug manufacturer in the world. Sales in 1979 were $.81 billion; 86 percent higher than 1974. Automotive products represent 75 percent of the company's sales and only 8 percent of total sales are to original equipment manufacturers. The company employs 16,000 people.

Champion has operating groups which market automotive components, coating equipment, health care equipment and steel products. The automotive group (about three-quarters of the company) makes spark plugs, jet igniters, other ignition items, windshield wiper blades, arms and refills.

Champion sees continued strength in spark plugs despite the trend to smaller engines, and has a goal of increasing its worldwide market share from 40 percent to 50 percent in the 80's. A continued decline is expected on the percentage of total revenues from U.S. passenger car spark plug sales, coupled with growth in spark plug sales overseas and in non-automotive markets. It plans to provide other aftermarket products with similar distribution requirements to those of spark plugs. The recent move into the windshield wiper market is an example of this latter trend.

Champion's return on equity has declined from 16.6 percent in 1975 to 14.8 percent in 1979. Earnings were about 7 percent of sales in 1979. Capital expenditures declined from 5.6 percent of assets in 1975 to 3.6 percent of assets in 1979. The firm's long-term debt is only 9.6 percent of total capitalization.

Champion operates 14 domestic plants and 26 facilities overseas. Champion acquired two new U.S. windshield wiper plants, in Gary and Valparaiso, Indiana, when it purchased the Anderson Company. A new, highly-automated wiper products plant was completed in Belgium in 1979.

COLT (HOLLEY CARBURETOR)

Holley Carburetor has been in business since the turn of the century and now ranks as the largest independent manufacturer of carburetors in the United States. Colt Industries acquired Holley in 1968 as part of a major acquisition effort. In the five years following 1969, the sales of Holley products quadrupled.

Colt Industries had sales of $2.1 billion in 1979, 87 percent higher than 1974 sales. In 1979, about 25 percent of total company sales were to the automotive industry. The 25 percent consists of 18 percent original equipment market and 7 percent aftermarket. Carburetors and components by themselves represent 10.7 percent of company sales. Other automotive products include specialty steels and seals. Colt employs 32,100 people.

Colt sees significant growth for Holley products in the 80's as automakers develop new designs for fuel economy and low emissions. Holley has been working for some time on electronically-controlled carburetors and is developing throttle bodies for fuel injection. The company is also working with Garrett to supply turbochargers for passenger cars.

Colt has had record-breaking performance in the last two years. In 1979 return on equity reached 20.3 percent and earnings were 5.2 percent of sales, somewhat higher than in the last five years. Capital expenditures have been a largely constant percentage of total assets (4.5 to 5 percent) in the last five years while the ratio of debt to total capitalization has fallen from 39 percent in 1974 to 28 percent in 1979. Colt had an A- Standard and Poor's bond rating in June 1979. The Holley division operates eight facilities totaling over one million square feet in five states (Michigan, Tennessee, Kentucky, Mississippi and Oklahoma).

In 1978 Colt began the construction of a new carburetor assembly plant in Bowling Green, Kentucky, to make fuel-efficient carburetors for 1980 and 1981 cars and trucks. Holley is also expanding capacity in Tennessee.

DANA

Dana was founded in 1914 as a manufacturer of universal joints. Original equipment components for passenger cars have accounted for the majority of sales for the company's first 50 years, but Dana has shifted heavily into production for light and heavy trucks and is now actively diversifying into the service and industrial markets.

Its sales were $2.76 billion (1979) compared to $1.1 billion (1974). The company employs about 36,500 people, derives about 10 percent of its revenues from sales to the OEM passenger car market and an additional 50 percent from OEM sales for other types of vehicles. Major products include axles, universal joints, driveshafts, transmissions and engine parts and frames.

Dana is organized into three major groups—a service group, industrial group and vehicular group. The vehicular group consists of a number of product line divisions with employment concentrated in the states near Michigan.

Dana is continuing to diversify. The firm has set the objective of increasing service and industrial sales each to 30 percent of the company total and of decreasing the proportion of vehicular sales to 40 percent of corporate revenues.

Dana's profits more than doubled between 1975 and 1979, its return on equity in 1979 was 19.6 percent and its earnings were about 6 percent of sales. Dana increased its capital expenditure rate to about 10 percent of assets during the past two years. Long-term debt as a percent of total capitalization rose to 22.3 percent in 1979.

Dana operates 130 facilities, of which 63 manufacture products for the original equipment vehicles market. The company recently acquired Wix Corporation which has five plants that produce filters. Dana also recently acquired two hydraulics companies and has begun to acquire financial institutions.

DELCO REMY (GENERAL MOTORS)

Delco Remy is part of the AC/Delco group of General Motors. Other parts of this group include Delco Moraine which manufactures brakes, Delco Electronics which manufactures radios and automotive electronic systems, Delco Products which manufactures shock absorbers and windshield wipers, and Delco Air Conditioning which makes automobile air conditioner compressors and controls. Delco Remy employs approximately 18,000 workers in the manufacture of batteries, maintenance-free batteries, starter motors, alternators, ignition systems and other electrical parts.

Delco Remy has come out with several important new products in the last few years. The company's "Freedom" or maintenance-free battery, which has a grid which virtually eliminates water loss in batteries, was a market breakthrough. Delco, in conjunction with GM's plans to produce electric vehicles in the mid-1980's, is working on a new technology nickel-zinc battery. Delco Remy's 225,000 square foot research center in Anderson, Indiana, employs about 500 people.

Delco-Remy has three electrical manufacturing facilities, the largest in Anderson, Indiana. Battery manufacturing plants are located in five different cities throughout the country to serve the original equipment market and provide batteries for national distribution to the replacement market.

EATON CORPORATION

Eaton's 1979 sales were $3.36 billion, almost double that of 1974. One-half of all sales are motor vehicle components. The company employs 57,800 people.

Eaton is organized into four major groups—the Automotive Components Group, the Industrial Group, the Instrument and Diversified Products Group and the Truck Components Group. Passenger car components (engine valves, hydraulic valve lifters, locking differentials and heater and air conditioning equipment) account for 9 percent of sales. Heavy-duty vehicle components include major systems such as transmissions and brakes and account for 40 percent of corporate sales.

Eaton has recently completed an aggressive acquisition campaign to broaden its product base and increase emphasis on high-technology products. The company is directing efforts toward expanding its foreign automotive markets and branching into new automotive growth areas, such as electronic controls.

Eaton's 1979 earnings were 4.6 percent of sales. Return on equity has been rising each of the last five years to 17.7 percent. Capital expenditures have generally been 5-6 percent of total assets. Long-term debt as a percent of capitalization in 1979 was 37.4 percent, having risen considerably in 1978 to fund acquisitions.

Eaton's Automotive Components Group manufactures parts and components in 21 facilities employing over 10,000 workers. Eaton is working on a number of expansion projects directed toward the heavy truck market. These include expansions in fluid power products, truck axles, and gear forgings.

While the automotive downsizing trend may decrease sales of some engine components, Eaton is planning to balance this trend through increased sales of emission control devices, safety-related components and speed controls. In addition, the firm is working on the development of new components for light trucks, a low tire pressure warning system and new fuel economy-related products.

FRUEHAUF

Fruehauf's sales were $2.45 billion in 1979, 86 percent higher than in 1974. It is the world's largest manufacturer of truck trailers/containers (57 percent of sales), and a major supplier of automotive parts and components (32 percent of sales). The company employs 33,100 people.

Fruehauf is divided broadly into three business areas: trailer operations, automotive/aerospace operations and maritime operations. Kelsey-Hayes (acquired in 1973) is the Fruehauf subsidiary responsible for most automotive parts and components sales and is operated as a separate company. Kelsey-Hayes is the largest independent producer of passenger car wheels, disc brakes, brake valves and skid-control systems for cars and trucks in the United States. Most sales are made directly to original equipment manufacturers (Ford, Chrysler, VW). Recent Kelsey-Hayes innovations include: fabricated aluminum wheels, lightweight brake systems and new hub and wheel bearing carrier assemblies for front-wheel-drive cars. Fruehauf hopes to strengthen its market position by providing products that can contribute to the auto manufacturers' attempts to reduce vehicle weight.

Fruehauf's return on equity has been rising over the past six years and is now at 17.9 percent. Earnings were 3.6 percent of sales in 1979. Capital expenditures rose to 11.2 percent of total assets in 1979 and the company's ratio of long-term debt to total capitalization has risen to over 40 percent. Capital expenditures have been running at about $100 million/year for the past two years (about 8 percent of assets).

Fruehauf has 50 manufacturing facilities in the United States. Plants of its Kelsey-Hayes subsidiary are highly concentrated in Ohio and Michigan. In 1978 Kelsey-Hayes opened a new, highly-automated plant in Sedalia, Missouri, increasing the company's wheel production capacity to over 40 million wheels per year. The company has also acquired Composite Engineering Corporation which provides a capability in reinforced plastics that Kelsey hopes to utilize in its development of lightweight automotive parts.

GOULD

Gould is an integrated manufacturer of electronic and electrochemical products with 1979 sales of $2.02 billion. Sales have more than doubled in the past five years and the OEM automotive market represents approximately 7 percent of the total, while automotive aftermarket products account for about 16.5 percent of sales. Gould employs 36,400 people.

Gould is divided into seven operating groups based on product: the battery group, electrical products group, fluid power group, government systems group, industrial group, instrument and controls group and the new products group. Automotive products include batteries, bearings, bushings, brake drums and discs, pistons, hose couplings, and elastomer products.

Gould is attempting to attain high market penetration in these markets which lend themselves to technological innovation. Over the past decade Gould has expanded by making 33 acquisitions including: Clevite (1969), I-T-E-Imperial (1976), Hoffman Electronics (1978), and recently, Bio-Mation Corporation.

Gould dedicates about 4 percent of sales to R&D and last year introduced over 100 products in the fields of: electronics, electrochemistry, electromechanics and electrometallurgy. A major current development program is directed toward improvement of battery technology for electric vehicles and/or utility load leveling application. Gould recently increased its market share of the replacement market for standard lead acid batteries from 11 percent to 20 percent with a new maintenance-free battery.

Gould's return on equity has been in the 15-16 percent range in recent years. In 1979 earnings were 5.2 percent of sales. Capital expenditures have been fairly consistent at around 7 percent of total assets. Gould has borrowed considerably in the last two years and its debt as a percent of total capitalization has changed from 25.6 percent in 1977 to 35.8 percent in 1979.

Gould operates a total of 107 plants in the United States, either directly or through subsidiaries. Automotive components are manufactured in approximately 18 percent of these plants, which are geographically disbursed.

MOTOROLA

Motorola is an important supplier of radios to the auto industry and has recently emerged as a major supplier of electronic engine control modules.

Motorola's sales in 1979 were $2.7 billion, almost double sales in 1974. Seven percent of company sales are directly attributable to automotive products. The company employs 75,000 people.

The company was important in the consumer television market until 1974 when it sold its Quasar television division. Radios, tape players and electronic ignition systems are manufactured in the Automotive Products Division. The company has two other major segments: a Communications Group, which is a major supplier of mobile two-way communication systems, and the Semiconductor Group, which manufactures electronic components and integrated circuits.

Motorola's business strategy in the past ten years has been to develop the company into a technologically advanced electronics organization that markets its products primarily to commercial, government and industrial users, not consumer markets. In the 80's the company hopes to increase its international sales and pursue new electronics opportunities such as digital communications and electronic engine controls.

Motorola's return on equity has been increasing every year since 1975 and reached 16.3 percent in 1979. Earnings in 1979 were about 5.7 percent of sales. However, Motorola's automotive group incurred an operating loss due to the downturn in U.S. new car sales and a reduction in the motor vehicle entertainment equipment business. Capital expenditures had a sizable jump in 1979 to 15.7 percent of assets. Long-term debt as a percent of capitalization rose from 18 percent to 22.7 percent.

Motorola has 19 major U.S. facilities and operates manufacturing or distribution facilities in 29 other countries. In 1979 Motorola Semiconductor announced it had started construction of a 120,000 square foot plant in Tempe, Arizona. The building will house Motorola's Microsystems unit which will build microcomputer development tools. In January 1979 Motorola won a contract to develop the microprocessor for GM's engine control module (ECM) and in August 1979 it was awarded a contract to supply ECM's to Ford, beginning in 1980. It now supplies distributorless ignition systems to Citroen.

SHELLER-GLOBE

Sheller-Globe produces over 800 different parts and components for the automotive industry including body parts (stamping), trim, gaskets, filters, motors, starters and "Superior" school buses. It had sales of $.65 billion in 1979, up 51 percent from 1975. The company derives approximately 75 percent of its revenue from sales to the auto industry and employs 13,000 people. In 1978, its primary customers were Ford (23 percent), Chrysler (14 percent), GM (13 percent), and the automotive aftermarket (13 percent.)

In order to strengthen its market position, Sheller-Globe restructured its manufacturing operations into four operating groups in 1979. These groups are: the Automotive and Truck Group, the Electrical Group, the Transportation Group, and the Office Products and Instrument Group. Major automotive products include stampings, assemblies, dies, die castings, hoods, fenders, and flexible urethane foam. For several years the firm's research and development activities have focused on new applications for plastics, elastomers and urethanes.

Detroit's increased attention to interior design and appearance in small cars represents an important market opportunity for Sheller-Globe.

In addition, to balance the cyclical trends of the automotive market, Sheller-Globe plans to expand its product line in non-automotive areas. During the 1980's it plans to initiate new programs and establish new facilities related to non-automotive products such as office equipment. Sheller Globe spent $4.8 million on R&D in 1978, up 22 percent over 1977.

Sheller-Globe's return on equity has declined from 25.3 percent in 1976 to 10.5 percent in 1979. The decline in 1979 has been attributed by the company to a decline in sales to the OEM automotive market. Earnings were 2.1 percent of sales in 1979. Capital expenditures were 7 percent of total assets and the ratio of long-term debt to total capitalization was 35.1 percent, well under the 39 to 40 percent range of 1974-1975.

Sheller-Globe has 22 plants, located in Ohio, Michigan, Iowa and Indiana, and Ontario, Canada, that manufacture primarily for the automotive market. In March 1979, Sheller-Globe acquired an existing 138,000 square foot plant in Morganfield, Kentucky,to expand its capacity to manufacture automotive interior trim.

TENNECO

Tenneco began business as a natural gas transmission company in 1940. It now ranks among the top ten industrial firms in the U.S. in terms of assets. Its 1979 sales were $11.2 billion dollars, more than double 1974 sales. Tenneco Automotive had 1979 sales of $.82 billion and employed 15,300 people. Automotive operating profit was $60 million.

Tenneco obtains two-thirds of its corporate income from energy-related businesses. Tenneco Automotive is operated as an independent operating company and was recently formed upon the acquisition by Tenneco of Monroe Auto Equipment in 1977. The company is now divided into the Monroe Auto Equipment Division, which makes shock absorbers; Walker Manufacturing Division, which makes exhaust systems; and Speedy Muffler King, which is a new retail chain selling mufflers. The replacement market accounted for 73 percent of Walker's and 78 percent of Monroe's total domestic sales in 1979.

Monroe has recently been successful in selling a large number of MacPherson struts to Chrysler. This reflects Tenneco's strategy of expanding sales to the OEM market by identifying future equipment needs and developing products that will meet these needs. Tenneco also relies on the brand recognition and experience it gains by being an OEM parts producer to enhance its ability to develop and market parts for the aftermarket, which account for over three-quarters of its automotive sales.

Tenneco's return on equity has been 15-16 percent over the last five years. While the automotive group contributes 7 percent of sales, it only contributes 4 percent to profits. Tenneco has maintained its debt to capitalization ratio between 41 and 46 percent over the last six years.

Walker operates ten domestic exhaust system manufacturing facilities and another 17 worldwide. Monroe has three manufacturing facilities in the United States (Nebraska, Georgia and Arkansas). Monroe has recently undertaken a $30 million expansion program (Canada, Arkansas and Georgia) to manufacture MacPherson strut suspension systems for front-wheel-drive cars from Chrysler.

TIMKEN

The Timken Company, founded in 1899, is the world's largest manufacturer of roller bearings and a leading producer of specialty steel and drilling bits.

Timken had sales of $1.3 billion in 1979, about 60 percent higher than 1975 sales. The company derives an estimated 20 to 30 percent of its revenues from sales to the auto industry and employs 23,500 people.

Timken is divided into two major operating groups: the bearings and bits group (71 percent of sales), and the specialty steel group (29 percent of sales). The company's leading product is tapered roller bearings used to counteract friction on axles and shafts in vehicles and machines. Other products include seamless mechanical steel tubing and removable rock bits. In 1979 Timken announced a new tapered roller bearing specifically designed to facilitate the manufacture and performance of front-wheel-drive vehicles. Timken has traditionally followed a conservative strategy toward the development of its business, choosing to concentrate in its three areas of expertise and experience rather than diversifying into new product lines. The company has indicated it will continue on the same course, and is now investing over $500 million in five years (1977-1981) to expand both bearing and steel production capacity.

Timken's return on equity has been a fairly steady 13 to 15 percent over the last six years. In 1979, earnings were 8 percent of sales. Capital expenditures have recently increased to over 13 percent of total assets. Long-term debt is a very low 3.8 percent of total capitalization.

Timken manufactures roller and ball bearings in five domestic plants (four in Ohio, one in South Carolina), produces steel in three plants, and rock bits and machine tools each in one plant. Recent capital projects include a new ($135 million) bearing plant in Lincolnton, North Carolina, and a new ($16 million) rolling mill in Canton, Ohio.

APPENDIX B

SUMMARY PROFILES OF U.S.-BASED MULTINATIONAL PARTS AND COMPONENTS SUPPLIERS

BENDIX

Bendix's sales in 1979 were $3.9 billion, up 55 percent from 1974. Automotive products account for 52 percent of sales and 50 percent of profits. The company employs approximately 76,000 people.

Bendix is organized into four major lines of business: Aerospace-Electronics, Forest Products, Industrial-Energy, and Automotive. Brake systems are the principal automotive passenger car product. Other products include steering systems, electronic engine controls and machine tools. Automotive sales are roughly divided into 55 percent domestic and 45 percent overseas sales. Forty percent of all sales are for aftermarket parts. Bendix has been a pioneer in electronic fuel injection and supplies parts for systems on many of today's cars.

Bendix' basic strategy throughout the 70's has been one of diversification. The company recently invested $128 million in ASARCO, a mineral company. Bendix is also relying on its technological strengths in manufacturing and electronics to deepen its penetration in existing markets.

Bendix' return on equity has been growing steadily in the last five years, reaching 16.7 percent in 1979. Earnings were approximately 4.2 percent of sales. Capital expenditures have varied between 6 and 8 percent of total assets in the last five years while debt, as a percentage of capitalization, has generally been near 26 percent.

Bendix has 15 automotive plants in North America, seven automotive plants in Europe, and several others throughout the world. Recent or planned expansions at Bendix have included a new ductile iron foundry in Quebec, an expansion of the Bendix do Brasil brake products plant and a capital outlay for equipment to produce fuel injectors for auto engines at Newport News, Virginia.

BORG-WARNER

Since Borg-Warner's beginnings 50 years ago, the transportation industry has been its most important market. Today the company is diversified, but remains a major supplier of transmissions, gears, torque converters and ABS plastic resins. Sales were $2.7 billion in 1979, with 12 percent for trucks and off-highway vehicles and 24 percent for automobiles. Sales for automobiles were strongest in transmissions and drive line equipment with 17 percent of total sales being auto components from the Transportation Equipment Group. In addition, 4 percent of sales were by the Air Conditioning group (York) and 3 percent by the Chemicals and Plastics group. About 42 percent of the Transportation Equipment group sales are for OEM automobiles, 22 percent for off-road and agribusiness, 12 percent for trucks, and 16 percent for replacement parts. Approximately 39 percent of Transportation Equipment group sales are derived from overseas markets, where the company is a major automatic transmission supplier. Borg-Warner employs 55,000 people in its 50 major divisions, with operations in 20 countries.

Borg-Warner has developed many new products in response to automakers' needs for fuel-efficient cars. These include "lock-up" torque converters, front-wheel-drive components, transfer cases, energy-saving fans, and new types of automotive plastics. Borg-Warner has gained access to the electronics field through a growing relationship with Germany's Bosch. In addition, one of Borg-Warner's recent major strategies has been to increase its participation in the service sector of the economy (13.5 percent of sales, up from 3 percent in 1968) as a means of reducing the effect of economic cycles on its performance. The recent acquisition of Baker Industries is consistent with this policy.

Borg-Warner has had improved earnings since difficult years in 1974 and 1975 and the automotive units have followed this same pattern. In 1979 earnings were 5.7 percent of sales, close to the highest level in the last six years. Return on equity was 15.4 percent. Borg-Warner has consciously reduced its debt to capitalization over the past six years, decreasing it from 25.8 percent in 1974 to only 12.4 percent in 1979. Borg-Warner announced in 1979 that it planned to build a $50 million plastics polymerization and compounding facility for ABS plastic at Port Brenville, Mississippi. In 1978, it spent $59.1 million on R&D, with a focus on energy conservation. New products include a line of microcomputer-controlled variable speed motor drives and AC inverters and an energy-saving variable speed transmission (by planned acquisition with Fiat of a 48 percent interest in Van Doorne Transmissie, B.V. of Holland).

THE BUDD COMPANY

Budd traces its history back to the second decade of this century when Edward G. Budd promoted the concept of stamped steel auto bodies and successfully sold the idea to the Dodge brothers. When Budd was acquired by the German steelmaker Thyssen AG in 1978, it had sales of $1.5 billion.

Budd is operated as an independent subsidiary of Thyssen. The company's activities are divided into four operating groups according to product. Automotive sales are primarily from the Stamping and Frame Products Group, which produces body stampings, and the Plastic Products Group which markets fiberglass-reinforced polyester compounds and molded products.

Budd is trying to build its business through increased sales of plastic parts to the auto industry and increased penetration of overseas markets. The company sees the merger with Thyssen as an important link to international markets and as a source of capital and technology. Budd is experimenting with graphite parts and with new methods of making cars crashworthy.

Fourteen Budd plants in North America sell products to the automotive industry. Budd recently reached an agreement to purchase Place Machine Sales Corporation of Troy, Michigan, and operate it as a subsidiary. Place manufactures special machine tools.

GOODYEAR

Goodyear's sales in 1979 were $8.2 billion, about 60 percent higher than 1974 sales. Sales of tires and related transportation products accounted for approximately 83 percent of total revenues. The company employs about 154,000 people, and is the largest tire company in the world.

Goodyear's corporate organization is functional rather than product-oriented. The company has the largest U.S. share of OEM tire sales (about 32 percent) and also has the largest share of the aftermarket (about 14 percent). Other major products include industrial belts and hoses, chemicals and wheels. Goodyear has recently introduced a series of tires called "Arriva" that combine all-season performance with good fuel economy.

Goodyear's approach to decreasing tire industry sales and the change to radial tires has been heavy investment to modernize its plants and increase radial production. Goodyear aims to survive the current turmoil and remain a major factor in the worldwide tire industry.

Return on equity was about 11 percent from 1974-1978 but decreased to 6.8 percent in 1979, as earnings fell from 3 percent to 1.8 percent of sales. Capital expenditures have increased in recent years and are now running at 7-8 percent of total assets. Goodyear has been increasing its debt in recent years, and long-term debt as a percent of capitalization increased from 31 percent in 1975 to 38 percent in 1979.

Goodyear manufactures its products in 63 plants in the United States and 49 in foreign countries. Production recently began at Goodyear's new Lawton, Oklahoma, plant, reportedly the most automated radial tire plant in the world. A $71 million radial truck tire expansion at Danville, Virginia, is underway. A new radial auto tire expansion at Gadsden, Alabama, was fully operational at the start of 1980. In 1979 Goodyear closed two outmoded bias tire plants in the U.S. and seems to be shifting U.S. operations away from the Great Lakes to the sun belt.

ITT

ITT is a $17 billion diversified company. Its automotive sales account for about 10 percent of total sales and 12 percent of operating profits, and the automotive division employment is about 38,000 people, of which 27,000 are based in Europe.

ITT is organized into large product-oriented groups. The automotive division, which is under the Engineered Products Group, is further made up of individual product-oriented operations, most of which are based in Europe. Alfred Teves GmbH in Germany is the world's principal independent manufacturer of disc brakes. SWF, also in Germany, is a leading supplier of windshield wiper systems and electromechanical/electronic components. IAO is the major independent automotive components supplier in Italy and Koni in Holland is a supplier of high-performance shock absorbers. ITT's U.S. automotive companies manufacture electrical components, fuel lines, plastic parts, metal trim, body hardware and brake shoes. ITT recently introduced U.S. production of disc brake caliper assemblies, shock absorbers and MacPherson struts. This is consistent with the company's strategy of increasing the percent of its earnings generated in the United States.

ITT's earnings have been about 4.3 percent of sales in recent years except for 1979 when earnings were decreased by a non-recurring charge. Return on equity has been steady, around 14 percent. Capital expenditures for ITT in recent years have been about 7 percent of sales. The capital structure of the company has also been very steady, with debt as a percent of total capitalization between 30 and 32 percent over the last six years.

ITT has major automotive facilities in North America, Europe, South America and Africa. Recently ITT opened a new automotive plant in Culpeper, Virginia, to make disc brake caliper assemblies for Alfred Teves and shock absorbers for Koni. ITT Suspension Systems Division has plans for a plant to make MacPherson struts for front-wheel-drive vehicles in Macon, Georgia.

TRW

TRW sales in 1979 were $4.6 billion, about 84 percent higher than 1974 sales. The company employs approximately 9,800 people and generates about 39 percent of its revenue from sales to the auto industry.

TRW was formed in 1978 with the merger of Thompson Products, a major producer of valves and other automotive products, with Ramo-Wooldridge Corporation, a leader in technology for Air Force ballistic missile programs. TRW is organized into four major divisions: Systems and Energy, Automotive Worldwide, Industrial and Replacement, and Electronics. Automotive Worldwide is subdivided into four operating groups corresponding to the major products of the division: engine, steering, chassis and general components. Of the car and truck sales, passenger cars account for 45 percent, trucks and off-road vehicles account for 31 percent, and replacement parts account for 23 percent of the total. TRW is now selling rack and pinion steering systems, which have been manufactured by the company for European customers for over 30 years, to North American auto manufacturers. The company is also marketing new bearings for front-wheel-drive cars and is developing vehicle electronics systems.

TRW's current automotive strategy is to increase market penetration with its steering, bearing and electronic products. The company also plans to increase its worldwide distribution capabilities in the aftermarket.

TRW has had recent strong earnings, with return on equity above 20 percent in each of the last four years. Earnings are currently about 4.3 percent of sales. Capital spending in 1979 rose to 8.1 percent of assets. TRW has reduced its debt as a percent of capitalization from 37 percent in 1974 to 26 percent in 1979.

TRW operates more than 100 manufacturing facilities in the United States and more than 90 manufacturing facilities in Europe and the rest of the world. Of the 21.6 million total square feet of domestic properties owned and leased by TRW, 23 percent are used for car and truck products manufacturing. TRW is completing a new multimillion dollar engineering center in Germany, where work will be done on steering gears, linkage and suspension joints for all types of vehicles.

APPENDIX C

SUMMARY PROFILES OF FOREIGN PARTS AND CONPONENTS SUPPLIERS

THE BOSCH GROUP

This company was established in 1886 and after periods as both a public and private firm it was reorganized in 1964 in its present form with 89.1 percent ownership by the Robert Bosch Foundation and 10.9 percent by Bosch family interests. At the end of 1979, it employed 121,395 people (a 2 percent increase over 1978) and derived 60 percent of its revenue from the sale of automotive components. Sales were DM 10.8 billion ($6 billion) in 1979, up 48 percent since 1975, with precisely one-half of sales outside Germany. Over the same period profits have fallen from 2.7 percent to 1.6 percent of sales, partly as a result of recent high investment levels. Investments in 1980 are expected to be about DM 800 million ($444 million). Given the nature of the firm and German accountancy principles, reported profits are not particularly relevant.

The company's automotive products are predominantly high-technology electrical/electronic components (39.3 percent), and mechanical/hydraulic/pneumatic components (23.3 percent). Bosch is a world leader in fuel injection technology. Non-automotive products include a wide range of capital goods, parts, and raw materials (10.2 percent), household appliances (18 percent) and technical consumer products (9.2 percent). Despite worldwide slowdown in automotive products, these Bosch groups have been growing. Its' Blaupunkt subsidiary (radios, TV, hi-fi, clocks, etc.) has suffered from Japanese competition.

In 1979, R&D expenditures were DM 676 million ($375 million), were largely internally financed and were focused on high-technology, energy-saving devices. A single project (fuel injection systems) accounted for 32 percent of R&D. Bosch has 6,595 employees devoted to R&D, 88 percent in Germany.

It has 1,520 employees in the U.S. Of these, 620 work at its diesel fuel injection equipment plant in Charleston, South Carolina; the remainder are involved in sales, service, and product distribution. It recently acquired Stanley Power Tools facilities in New Bern, North Carolina, as a machine tool interest. Bosch anticipates a 25 percent annual growth rate in fuel injection system sales worldwide.

DUNLOP HOLDINGS LTD.

Dunlop registered in the U.K. to produce tires in 1896. It pioneered the international tire business and currently has over two-thirds of its assets outside the U.K. It operates in a group including Dunlop (U.K.) and Pirelli (Italy) with 150 factories in 22 countries. It employed 96,000 at the end of 1979 (down 6 percent from 1977) with sales of about $3.6 billion. Dunlop, along with Michelin, accounts for the vast majority of European-based worldwide tire activity. Markets for tires are contracting due to radial tire technology (long-life), competition from cheap Eastern European tires, and over-capacity (competition) in Europe.

Dunlop is diversifying into related automotive products, i.e., hydraulic hoses, suspension units, fluid seals, as well as industrial automation, soil-less cultivation systems, and space heating pipe-systems. It builds automotive wheels. fire engines, liquid/gas springs and even horse trailers in the U.K. Employment is 66 percent in Europe, as are sales (63 percent), the majority being in the U.K. In 1978, Dunlop employed about 4,000 people in North America at plants built in Buffalo (1923), Huntsville, Alabama (1969), and South Carolina (1977). Sales were £168 million ($400 million) in North America (11.4 percent of total sales) in 1978, of which 70 percent were tires.

Dunlop introduced run-flat tires in the spring of 1972 and more recently added a puncture-sealing feature, but found the market limited to top-of-the-line cars due to price. Dunlop is still working on tires which cannot possibly deflate to eliminate spares, but product research priority is on automotive components markets other than tires. Between 1975 and 1979 sales have risen 57 percent, but operating profit has fallen from 6.3 percent to 4.1 percent of sales. Dunlop's future depends upon success of current profit improvement programs, favorable trends in interest and exchange rates, and world trading activities in 1980.

MICHELIN

Established in 1893 as a rubber processing company, the Michelin group now consists of a complex group of manufacturing, distribution and financial companies. The group maintains absolute secrecy, to the extent possible, about all aspects of its operations. Its tire manufacturing operations are controlled by two companies—Manufacture Francaise des Pneumatique Michelin (19 factories in France), and Compagnie Financiere Michelin (Basle, Switzerland), which controls manufacturing subsidiaries (factories) in Italy (6), West Germany (5), Spain (4), Belgium (1), Holland (1), the U.K. (6), Canada (2), Nigeria (1) and the U.S. (4), for a total of 26 factories outside France. In 1979, Michelin had turnover (sales) of F23.9 billion ($5.7 billion), which was double that of 1975. Net profits were 2.5 percent of sales in 1979, but have ranged between 3.2 percent and 4.6 percent during the previous five years.

Michelin employs about 110,000 people worldwide. The bulk of its manufacturing activities are associated with radial tires, i.e., rubber, steel cord, wheels, rims, etc. About 3 percent of sales are allocated to R&D with the main research center at Ladoux, France. About 4,500 people are employed at this laboratory/test facility and at test facilities in the U.K., Spain, and U.S. (Laurens, South Carolina). Michelin's marketing policies allow great flexibility for each distribution unit to act independently of production units. This highly aggressive marketing approach has allowed it to capture the market share during a gloomy period for the tire industry as follows: France (60 percent), West Germany (30 percent), Italy 35 percent), U.K. (24 percent) and U.S. (5 percent cars/8 percent trucks).

Michelin plans to divest Kleber Colombes, the other French tire company which it has recently controlled. It has built four factories in the U.S. in South Carolina and Alabama since 1975, and is building a fifth (Columbia, South Carolina). It has two factories in Canada (employment 3,600) and is building a third in Nova Scotia. Of the eight additional new factories planned only two are in France; the other six are planned for Egypt (1), Brazil (2), and U.S. (3), all in Texas.

Michelin's fuel-efficient tires, production techniques, and low labor cost locations appear to give it a market advantage in North America. Based strictly upon limited intelligence about Michelin's facilities plans it appears to be aiming to double its market share in North America in the next few years.

GUEST KEEN AND NETTLEFOLDS LIMITED (GKN)

The GKN Group of 300 companies employs 100,000 people around the world. Annual turnover is about £2 billion, about one-third of which ($1.6 billion) is automotive components. For the past five years surplus on trading (profits) was 5 to 7 percent of turnover (sales). GKN is highly integrated and is the largest user of steel in the U.K. Automotive-related products include axles, transmissions, forgings, locks, fasteners, powder metallurgy products, and drive line components. GKN, for example, produces about 90 percent of the world's requirements for constant velocity joints (40 million/year). These joints are essential components for front-wheel-drive, downsized automobiles and were developed for the original Leyland Mini.

In October 1979 GKN also won initial orders ($12 million) to supply aluminum wheels to Chrysler and Ford. As many of its products and processes were developed to support the manufacturing of small fuel-efficient vehicles, GKN is interested in the U.S. market. In 1978, it invested about £21 million ($50 million) for a constant velocity joint plant in Sanford, North Carolina, to produce 400,000 car sets per year for Ford. A second plant (£35 million—$84 million) with twice the capacity is being built for mid-1981 start up about 50 miles from Sanford. Total employment of the two plants will be 1,100 people. A third U.S. plant may be announced soon.

GKN's foothold in the U.S. may be expanding rapidly in other component areas, with the purchase (in February 1980) of 80 percent of Maremont Corporation's (Chicago) Worldparts Division (aftermarket components and accessories). This follows recent forward integration into distribution via acquisition in the U.K. (Armstrong Equipment in August 1979) and France (Unigep).

VALEO GROUP

Valeo is the new name for French Ferodo, a company established in France in 1923 as a spin-off of the U.K. firm of the same name. It began as a friction material producer and expanded into mechanical components (clutches, cooling systems). In the late 1960's it got into automotive electrical components by taking an interest in SEV-Marchal. In 1977 it acquired both Paris-Rhone and Cibie. In 1978 it acquired SOMA Europe Transmissions to become an automotive components giant with sales of F6.05 billion ($1.45 billion) in 1979. In 1978/1979 the company rationalized its 30,900 person organization into three groups, as follows:

- Equipements Electriques Automobile (EEA): headlights, ignition parts, etc.—37 percent of employment and 44.5 percent of sales

- Equipements, Automobile Mecaniques et Thermiques (EAMT): friction materials, transmissions, heating and cooling systems, etc.—42 percent of employment and 40.1 percent of sales

- Equipements et Produits hors Automobiles (EPHA): parts for industrial vehicles, building materials, and domestic appliances, etc.—18 percent of employment and 15.4 percent of sales.

The remaining 3 percent of employees are independent from the three main groups. In summary, the Valeo group has 30 different product lines and sells to 23 vehicle manufacturers worldwide, with substantial market shares in Germany, Holland, Belgium, the U.K., Italy and Spain. Sales are made under a wide variety of brand names, many of which were carried over from acquired firms.

Acquisitions have increased sales by 217 percent since 1974. Net profits on sales were 3 percent in 1979, but varied from 1.3 percent to 4.1 percent over the past five years in a generally upward trend. Long- and medium-term debt has grown from negligible to 36.6 percent of net assets since 1977. About 5 percent of sales go to R&D which has emphasized the electrical products group needs (EEA), with a major research center at Toulouse and a new electronics division at Beaugency. A major emphasis is being placed on electronic control modules. Valeo and Lucas maintain a joint interest in Ducellior, the second most important electrical automotive equipment producer in France.

LUCAS INDUSTRIES LTD.

Lucas is made up of eight principal operating companies, has 45 major manufacturing facilities and 87,543 employees worldwide. The automotive components sector accounted for about 80 percent of sales of £1.07 billion ($2.57 billion) in 1979, an increase of 88 percent since 1975. Profits before "interest on loan capital and taxation" were 7 percent of sales and 15 percent of "capital employed." Major U.K. companies and products are as follows:

- Lucas Electrical Ltd.: Ignition and fuel injection systems, windshield wiping systems, horns, lights, starters, generators, switch gears, relays, solenoids, automotive trim products, etc. (17,000 employees)
- Lucas CAV Ltd.: Diesel fuel injection equipment, heavy-duty electrical equipment, and filters for commercial/military vehicles (13,000 employees)
- Lucas Girling Ltd.: Shock absorbers, brake and clutch equipment (8,050 employees)
- Lucas Batteries Ltd.: Batteries for all vehicle applications (1,600 employees)
- Rists Ltd.: Electrical cable/components (4,000 employees)
- Lucas World Service, Lucas Aerospace, and SMEC Ltd.: Other groups in the U.K. in service and distribution, also holding companies for products of subsidiaries.

Overseas ventures, which manufacture similar products, accounted for 43 percent of sales in 1979. Sales in Europe increased to 25 percent and in North America to 4 percent. In October 1979 Lucas announced a $72 million order from GM for fuel injection systems for U.S. diesel cars and is bidding a GM starter order. In the U.S., Lucas has a headquarters/test center in Troy, Michigan, and a 25,000 square foot factory in Greenville, South Carolina, to assemble/test diesel fuel injector pumps from U.K. components. Intentions are to introduce complete local U.S. manufacture "when the conditions are right."

R&D focuses on microelectronics, improvements in manufacturing processes, lightweight brakes, electric vehicles, on-board diagnostics/control modules, and digital fuel injection. A new factory was acquired in Birmingham to supply this latter product for Jaguar V-12 and Rover V-8 engines.

APPENDIX D

SUMMARY PROFILES OF MAJOR MACHINE TOOL COMPANIES

ACME-CLEVELAND

The Acme-Cleveland Corporation, formed in 1968, ranks among the top five North American manufacturers of machine tools in both revenues and income. In 1979, Acme-Cleveland had sales of $344 million and profits of $19.6 million. The firm employed about 6,100 people in 1979.

Acme-Cleveland's products are divided into two categories. The capital equipment segment of the company's business produces machine tools and systems and foundry equipment. The other category is expendable products such as cutting and threading tools.

The automotive industry accounts for about 50 percent of Acme-Cleveland's total annual sales. Ford and General Motors are its largest customers, with combined sales of about $96.6 million in 1979. Major automotive products include machine tools and transfer lines for the production of pistons, connecting rods, rear axle housings, cylinder heads, disc brakes and other vehicle components.

The major redesign and retooling efforts of the U.S. auto manufacturers have resulted in a significant increase in sales to automakers in recent years. Company sales in 1979 represented a 19 percent increase over 1978, and earnings rose 48 percent over this same time period. Return on equity in 1979 was 19.3 percent, a significant increase of the 1978 and 1977 percentages of 14.8 percent and 5.8 percent respectively. The company's order backlog increased 80 percent between 1979 and 1980. Sales and profits are expected to continue to improve in 1980.

Acme-Cleveland's corporate strategy focuses on expanding and improving its production capabilities to meet the increased needs of the automakers. In recent years, the company has opened a new manufacturing facility and implemented an automated data processing system to improve operational efficiency. Company capital expenditures of $14.7 million in 1979 were 64 percent higher than 1978 expenditures. Capital investments have been funded primarily by internally generated funds with some outside borrowing. The company's percentage of long-term debt to capitalization has remained in the 30 to 32 percent range during 1976-1979. The company is currently in a strong cash flow position.

CINCINNATI MILACRON

Cincinnati Milacron, a 96 year old company, is the largest manufacturer of machine tools in the U.S. and an industry leader in the production of computer-numerically controlled machines. In 1979 the company achieved record sales and profits of $634 million and $55.4 million respectively. In 1979 the firm employed about 13,700 persons, 3,700 of them at facilities overseas.

The company is structured according to three product groups. They are the Machine Tools and Electronic Systems Group, Plastics Processing Machinery Group and Industrial Products Group. The automotive industry accounted for about 14 percent of 1979 machine tool orders and plastics machinery sales. An unspecified part of industrial product sales were also sold to the auto industry. Specific automotive products include standard and special purpose machine tools, machining centers, industrial robots and plastic processing equipment. Major automotive customers include General Motors, Ford, Chrysler and Volvo.

The company has had record earnings and order backlogs for several years. Sales in 1979 represent an 18 percent increase over 1978 sales of $748 million. Earnings in 1979 represent a 16 percent increase over 1978 profits of $33.2 million. Return on equity in 1979 was 24.5 percent, an increase over the 1978 figure of 17.5 percent. Most of the company's capital expenditures of $36 million in 1979 have been funded through internally generated cash. The company's percentage of long-term debt to capitalization has declined from over 40 percent in 1975 to under 30 percent in 1979.

The company's corporate strategy focuses on maintaining a leading position in the U.S. machine tool and plastics equipment markets and divesting the company of unprofitable facilities and products. In the past four years the company has sold six marginally profitable product lines in the U.S. The company is concentrating on improving its electronic capabilities, particularly in relation to the industrial robot market. The company reported $14 million in robot sales to two auto manufacturers in early 1980 and expects robot sales for the year to triple those of 1979.

CROSS & TRECKER

Cross & Trecker was formed in 1979 through the merger of the Cross Company and the Kearney and Trecker Corporation, a merger currently being challenged by the Justice Department for alleged antitrust violations. The company is a major manufacturer of automated metalcutting transfer lines; assembly and testing machines; stand-alone machine tools; automated systems for foundries; and automated coal-handling systems. In 1979, the company had sales of $298 million and profits of $26.4 million. The firm employed about 4,100 people in 1979.

The worldwide auto and truck industry is the firm's largest single customer representing about 50 percent of total annual sales. Major automotive products include metalcutting, assembly and test machines for manufacturing component parts and assemblies. The company sells to 20 auto companies worldwide. Ford, General Motors and Caterpillar each accounted for more than 10 percent of company revenues in 1979. Company plants that make significant shipments to the automotive industry employ about 1,900 people and occupy 360,000 square feet.

Cross & Trecker's 1979 sales represent a 28 percent increase over the combined 1978 sales of the two companies prior to merger. Likewise profits in 1979 represented a 54 percent increase over combined profits in 1978. Return on equity improved after the merger and reached 22.4 percent in 1979. Long-term debt to capitalization percentage in 1979 was 3.1 percent, a decline from 6.5 percent prior to the merger.

The company's strategy is to provide products to the entire spectrum of metalworking markets. The merger combines Cross' high-volume metalworking products with Kearney and Trecker's low- and medium-volume products. The company is committed to a $65 million, three-year expansion program; aimed at increasing capacity and accelerating new product development. The expansion program stems from the large backlog and high rate of new orders from the auto industry and is aimed at increasing worldwide annual sales capability to the $500 million level. The program includes the construction of new or expanded facilities in Michigan, Kentucky, Wisconsin and Alabama. Recent new products include a 34-station nonsynchronous transfer machine for the assembly and testing of auto master brake cylinders.

GIDDINGS AND LEWIS

Giddings and Lewis, founded in 1859, is one of the five largest machine tool manufacturers in the U.S. In 1979, company sales and profits were $258 million and $28.9 million respectively. The firm employed about 4,100 persons in 1979.

The company's major product lines are machine tools, industrial brushes and steel cylinders. Each of these product classes accounted for more than 10 percent of annual sales during the years 1975 to 1979. The company is organized in two operating groups—Machine Tools and Industrial Products.

Automotive manufacturers account for 25 to 30 percent of total sales. Major automotive products include transfer lines, machining centers, turning centers and automatic assembly systems.

Company sales and earnings have risen steadily in recent years. Company sales in 1979 represent a 30 percent rise from 1978 sales of $199 million. Profits in 1979 represent a 59 percent increase from $18.2 million in 1978. Return on equity has shown a sharp upward trend, tripling between 1975 and 1979 when it reached 32.4 percent.

Capital expenditures have increased in recent years, reaching more than $10 million in 1978 and 1979. Long-term debt to capitalization percentage has declined from around 30 percent during the period 1975 to 1977 to less than 20 percent in 1979.

Corporate strategy is to diversify its product lines through the expansion of its Industrial Products Group. The company has recently pursued an aggressive acquisition program, purchasing five companies in five years. The purpose of its diversification program is to counteract the cyclicality of the machine tool industry. The sales goal of industrial products is 50 percent of total sales. In 1979, the industrial product lines accounted for about 25 percent of the total.

The company is also developing new products to meet the requirements of current large customers like auto manufacturers such as new transfer lines. One of the company's latest projects has been the production of a 50-machine integrated manufacturing and assembly system for the Maskvich Auto Plant in the USSR. In 1979, the company spent $9.1 million on research, product development and engineering, up from $7.7 million in 1978.

JOS. F. LAMB

The Jos. F. Lamb Company is a privately held manufacturer of transfer lines and other dedicated machining systems. It ranks among the top ten U.S. machine tool builders. Firm sales in 1979 were in excess of $200 million. Total employment was about 1,400 people in 1979.

The company is divided into two distinct parts: Machine Tools Group and Systems Products Division. The Machine Tools Group manufactures transfer lines, machining centers and standard machine tools. The Systems Products Division is primarily engaged in producing automated systems to complement the products manufactured by the Machine Tools Group.

Auto companies account for approximately 85 percent of total company sales. The balance of sales are primarily to heavy equipment manufacturers. Automotive customers include General Motors, Chrysler and other U.S. vehicle manufacturers. In marketing to the automakers, Lamb relies heavily on its long-standing close relationship with the industry and on a reputation for engineering excellence. A large percentage of the company's products are custom designed for individual manufacturers. The company's "state-of-the-art" product is a high volume, turnkey machining line that is able to take a raw casting of a component, such as a cylinder head, and turn out a completely machined component. The system typically includes a transfer line, automation components, cleaning, washing and filtration equipment, gauging mechanisms, and computers and industrial robots as required.

Lamb has five facilities that manufacture transfer lines and other products used by the auto industry. These plants are being expanded and updated to meet the increasing demands of the auto industry. The company was recently awarded six contracts by auto manufacturers for transfer and machining lines. Five of the orders have come from divisions of General Motors and one from Chrysler.

MOTCH & MERRYWEATHER

Motch & Merryweather is one of the top ten U.S. machine tool manufacturers and the largest distributor of machine tools in the U.S. In 1978, the company had sales of $116 million and profits of $4.2 million. The company was purchased by Oerlikon-Buhrle Holding AG of Switzerland after operating for 75 years under the control of the Motch family. Since the acquisition, financial performance for the Motch & Merryweather Company has not been reported.

The firm manufactures chucking and grinding machines, transfer lines and abrasives for grinding. It also distributes a broad range of machine tools produced by other manufacturers. Approximately half of the firm's sales are derived from distribution of other companies' products.

The auto industry is one of the company's largest markets, accounting for about 30 percent of company sales. Sales to General Motors are about half of all sales to the auto industry. Other markets include aerospace, agricultural machinery, metalworking and power industries.

Prior to acquisition, Motch & Merryweather's sales increased over 1976 to 1978. Sales in 1978 represented a 51 percent increase over 1976 sales of $77 million. Profits in 1978 were nearly double the 1976 profits of $2.2 million. The company's return on equity improved over this time period from 12.9 percent in 1976 to 18.7 percent in 1978.

Long-term debt increased by $5.8 million in 1978. In contrast, long-term debt declined in the years 1975, 1976, and 1977. Long-term debt to capitalization percentage was 38.3 percent in 1976, 34.0 percent in 1977 and 39.7 percent in 1978.

The merger will permit joint machine tool development and production. Motch & Merryweather also plans to distribute those Oerlikon products that fill gaps in Motch's current product lines. For example, the company will attempt to interest the auto industry in Oerlikon's line of deep-boring equipment.

APPENDIX E

SUMMARY PROFILES OF SEVEN STEELMAKING COMPANIES

U.S. STEEL

U.S. Steel is the largest integrated producer of steel and steel products in the U.S. and one of the most diversified. The firm's business ventures extend from steel manufacturing and finishing to chemicals, resource development, fabricating and engineering, and domestic transportation and utilities. Sales in 1979 were about $13.0 billion. However it lost $293 million after writing down $800 million in plant closings and recording a $561.7 million fourth quarter loss. The company employed about 171,600 persons in 1979.

Major markets (for the steel manufacturing group) include transportation, steel service centers, construction, containers, machinery and others. Shipments of steel were 21 million tons in 1979, up slightly from 20.8 million tons in 1978. About 17 percent of 1979 steel shipments went to the transportation market including the automotive industry. Major automotive products include hot and cold rolled sheets, coated sheets, hot rolled strip, and hot rolled bar. Automotive applications of these material products are found in car bumpers, wheels, frame members, engine mounts and body and structural panels. U.S. Steel is developing new automotive products to reduce car weight and improve corrosion resistance. In weight reduction, the firm's latest development is Dual Phase 80, a high strength steel that increases in strength after forming. In corrosion resistance, U.S. Steel is advertising their product GALVA-ONE, a one-sided electrogalvanized sheet that gives effective corrosion protection, along with outside paintability.

Although sales have continued to increase over the past five years, earnings have fluctuated dramatically from year to year. Sales have increased steadily from $8.2 billion in 1975 to $12.9 billion in 1979. However, the 1979 loss of $293 million represented a 227 percent decline from 1978 earnings of $242 million. The 1978 earnings represented an increase over 1977 earnings of $138 million.

Capital expenditures were $929 million in 1979, an increase over 1978 expenditures of $667 million in 1978. The company's long-term debt obligation increased by $106 million in 1978. Its long-term debt to capitalization percentage was 29 percent in 1979, the highest since 1974.

BETHLEHEM STEEL CORPORATION

Bethlehem Steel Corporation is an integrated producer and distributor of steel and steel products, and one of the five largest steel producers in the world. Bethlehem's sales in 1979 were $7.1 billion and net income was $275.7 million. The company employed about 97,700 persons in 1979.

Bethlehem's major markets include automobile and light truck, heavy truck and off-highway, railroad, building and construction, equipment and machinery, consumer durables, and marine transportation. Nearly 30 percent of total company sales are to transportation equipment manufacturers and about 20 percent of total sales are to the auto industry in particular. In addition to GM, Ford and Chrysler, Bethlehem ships to a variety of independent automotive suppliers.

Major automotive products include hot and cold rolled sheet steel and strip steel, high strength/low alloy steels, galvanized steel, aluminized steel (galvalume) and steel bars. The company is currently promoting and advertising to the auto community a wide range of special application steels such as corrosion resistant Bethcon, Galvalume and Automotive Jet coat sheet steels, along with its "normal" range of carbon sheet steels and bars. This advertising is part of its overall strategy to market and promote new and innovative products in their strong markets.

In recent years, Bethlehem's financial statistics have improved following a poor performance in 1977. In 1977 the company sales were $5.4 billion; however, the company lost $448 million. Sales in 1978 and 1979 were $6.2 billion and $7.1 billion respectively. Earnings in 1978 and 1979 were $225 million and $276 million respectively. The company's return on equity percentage was 11.2 percent in 1979, up from 9.9 percent in 1978.

Bethlehem is one of the few steel producers to actually decrease overall capacity in the last few years. But while decreasing absolute capacity, it has modernized existing facilities with the latest technology, improving productivity and operating efficiency. Capital expenditures were about $420 million in 1979 and are estimated to be about $550 to $600 million in 1980. Much of 1980 expenditures are directed toward the relining of several of the firm's blast furnaces for more efficient operation. Long-term debt obligations increased by $8 million in 1979, after declining by $155 million in 1978. Bethlehem's long-term debt to capitalization percentage was 28 percent in 1979, down from 29.8 percent in 1978.

JONES & LAUGHLIN STEEL (LTV)

The acquisition of Lykes Corporation by LTV Corporation brought together the steelmaking operations of Jones & Laughlin Steel (LTV) and Youngstown Sheet & Tube (Lykes) in late 1978. With a combined capacity of about 12 million tons of steel per year, Jones & Laughlin (YS&T identification has been dropped) became one of the five largest producers in the U.S. Together, the two operations had sales of $4.2 billion and earnings of $170.7 million in 1979, an improvement from 1978, when the two steelmakers operating separately recorded sales of $4.3 billion—yet a loss of $93 million. Total employment in 1979 was about 26,200 persons.

The automotive industry is a primary market for Jones & Laughlin. In 1979, sales to the auto industry accounted for 24 percent of sales. The steelmaker's largest single customer, General Motors, has averaged nearly 10 percent of annual gross sales over the period 1975-1979. Major automotive products include hot and cold rolled carbon sheet steel, steel bars, high strength/low alloy steels and galvanized carbon steels. The major product purchased by automakers is flat rolled sheet produced at the Cleveland, Hennepin and Indiana Harbor plants. The company is concentrating on developing strong lightweight steels for new products to the auto industry.

Before the acquisition of Lykes, total corporation sales for LTV were fairly stable, ranging from $4.3 billion to $4.8 billion over the years 1974-1977. After the merger, sales increased to $5.3 billion and $8.0 billion in 1978 and 1979 respectively. Corporate earnings were a negative $22.9 million in 1977, yet improved up to $39.6 million and $147 million in 1978 and 1979 respectively. Return on equity percentage was 39.3 percent in 1979, up from 4.1 percent in 1978. Long-term debt obligations declined $30 million in 1979 and the company's long-term debt to capitalization percentage was 68 percent in 1979, the lowest in the past six years.

ARMCO INCORPORATED

Armco is one of the ten largest steelmakers in the U.S., with shipments of eight million net tons in 1979. The company is a fully integrated producer of steel and related products. Its primary products are carbon and specialty steels. Armco's sales in 1979 were $5.0 billion and profits were $221 million. The firm employed about 54,800 persons in 1979.

Armco's single largest market in 1979 was the construction industry, replacing the automotive community for the first time in many years. About 20 percent of Armco's steel sales went to the auto community in 1979. Major automotive customers are General Motors, Ford, and Chrysler as well as a variety of independent automotive suppliers. Major automotive products include hot and cold rolled sheet carbon steel, HSCA steel, and carbon steel galvanized on one side (Zincgrip). Armco's Zincgrip is corrosion-resistant on the inside but highly paintable on the outside. Virtually all of Armco's sales to the automotive market are from the carbon steel division which operates eight major plants around the U.S. Nearly all of Armco's automotive steels are produced by the Ashland, Kentucky, and Middletown, Ohio, plants. Roughly 40 percent of these plants' shipments are to automotive customers. Combined employment of both plants is about 11,000 people.

Armco's financial position has been steady over the past five years. Sales have continued to increase from $3.0 billion in 1975 to $5.0 billion in 1979, and earnings have also increased from $117 million in 1975 to $221 million in 1979. The company's return on equity percentage was 13.5 percent and 13.1 percent in 1978 and 1979 respectively. The company has reduced its long-term debt obligations in each of the past three years (1977, 1978 and 1979) by about $30 million in each year. The company's long-term debt to capitalization percentage declined from 29 percent in 1979 to 26 percent in 1978, and to 23 percent in 1979.

Armco's overall strategy is to strengthen its non-steel operations while keeping steel production growth strong. The firm intends to reduce carbon steel from 63 percent of Armco's asset mix to 45 percent while increasing specialty steels to 12 percent. Other non-steel divisions are expected to grow as well.

NATIONAL STEEL

National Steel is one of the five largest steel producers in the United States and has for many years been the steelmaker with the largest percentage of its sales shipped to the automotive community—as much as 30 percent. National had sales of $4.2 billion in 1979, 55 percent higher than sales in 1974. National employs about 39,000 people and generates about 22 percent of its sales from the auto industry.

National has recently been promoting its lightweight and corrosion resistant steels to the auto market. The company is also experimenting with steel clad aluminum for automotive applications. As recently as ten years ago, more than 30 percent of National's sales were to the auto industry. Since then the company has been diversifying and its current strategy remains to maintain a strong position in the automobile and can markets while decreasing overall dependence on both.

National's earnings continue to be low by several measures, such as return on equity which was 9.2 percent in 1979. Earnings were 3 percent of sales, an amount typical of the last six years. National had large capital expenditures in 1975 and 1976 and increased its debt in those years. Since then capital expenditures and debt have decreased with the ratio of debt to capitalization declining from 33.6 percent in 1976 to 28.1 percent in 1979.

National has traditionally expended considerable effort to keep its internal procedures and plant technology at the forefront of manufacturing technology, and a great deal of its research and development effort still goes to that end. National is currently refining techniques to introduce argon gas into basic oxygen furnaces, a process with favorable effects on product quality and cost.

REPUBLIC STEEL

Republic is the largest producer of alloy steel in the world, and the U.S. steelmaker most dependent on the automotive industry. Sales in 1979 were $4.0 billion, 48 percent higher than 1974 sales. The company employs 42,690 people and derives more than 23 percent of its sales from the auto industry.

Republic has recently introduced a series of steel bars and sheets especially designed for automotive use. The new steel is highly formable, lightweight and strong. Seventy-five percent of Republic's shipments are in flat rolled and bar steels, and all of the company's business is steel or steel-related. Republic continues to express no interest in diversifying into non-steel areas. The company, however, is attempting to improve product mix by optimizing its strong position in alloy and high grade carbon products, special metals, stainless, specialty flat rolled products and pipe.

Although Republic's 1979 earnings were the second highest in history, return on equity was only 8.4 percent and earnings were 3 percent of sales. Republic has increased its ratio of long-term debt to capitalization from 16 percent to 20 percent in the last six years.

Republic's capital expenditures budget for 1979 was $341 million. Much of this was directed at the company's Mahoning Valley district, undergoing a major modernization program that will eventually phase out blast furnace operations in Youngstown and concentrate the district's primary operations in Warren, Ohio.

INLAND STEEL COMPANY

Inland Steel Company is a major fully-integrated steelmaker with only one plant—the largest one in the country (Indiana Harbor). Inland generates about 20 percent of its $3.6 billion in sales from the auto industry and employs 37,341 people.

More than 95 percent of Inland's product mix is either carbon or HSLA steel. Inland's overall marketing strategy is to stress the advantages of its single, highly efficient mill and the speed with which its highly trained sales representatives can call forth shipments from the Indiana Harbor complex. Inland will soon complete a $1 billion program to increase the Indiana Harbor plant's raw steel capacity from 8.2 million tons to 9.3 million tons and to increase annual steel mill capacity from 6.1 million net tons to 6.9 million net tons.

Inland earned 3.8 percent on sales in 1979 and its return on equity was 10.3 percent, down from the 13.2 percent of 1978 but higher than any year since 1974. The company has maintained its debt to capitalization ratio near 30 percent over the last six years.

APPENDIX F

SUMMARY PROFILES OF THE ALUMINUM COMPANIES

ALUMINUM COMPANY OF AMERICA (ALCOA)

ALCOA is the largest aluminum producer in the U.S. and the world's leading integrated producer of aluminum products. ALCOA had record sales and earnings in 1979 of $4.8 billion and $505 million respectively. The company employed about 46,800 workers in 1979.

ALCOA's major markets are packaging and containers, building and construction, transportation, electical and finished aluminum products. In 1979, 15 percent of total sales went to transportation. About 5 percent of total sales went to the auto industry. Major automotive products include sheet, forged wheels, bumpers, trim sheet, fasteners, fin stock and ingot. New products supplied to the auto industry include ALCOA's 7,000 series aluminum used for auto bumpers and bumper back-up bars and its new 6XXX series aluminum body sheet.

ALCOA's marketing and R&D strategy has been to change its product mix to focus on those markets that play to ALCOA's strengths—where high-volume, high-technology, and energy-conserving products are vital. It sees its biggest growth potential in the automotive market. It feels future cars will contain more aluminum to reduce weight and to improve energy efficiency. The company is engaged in considerable research and development in new uses for aluminum in cars. R&D expenditures were $50 million in 1979.

ALCOA has ten plants that provide parts to the auto industry. Three of these make small aluminum parts like fasteners and powdered metal parts. The other seven make sheet, extrusions, forging and primary aluminum. ALCOA undertook several automotive-relevant plant expansions and modifications in 1979. For example, production of bumpers for GM's X-model cars in its Sidney, Ohio, plant was expanded. Capital expenditures were $420 million in 1979.

Earnings have risen steadily over the past five years, from $2.3 billion in 1974 up to its record high of $4.8 billion in 1979. Likewise, profits have increased from $65 million in 1975 to $504 million in 1979. Return on equity in 1979 was 16.1 percent, a dramatic increase over its return on equity of 4.1 percent in 1975. Long-term debt declined in 1979 by $36 million. Its long-term debt to capitalization percentage was 26 percent in 1978, the lowest in the past six years.

ALCAN ALUMINUM CORPORATION

Alcan Aluminum Corporation is the American subsidiary of Alcan Aluminum Ltd., the world's largest producer of aluminum. The subsidiary sells primary aluminum and extruded aluminum manufactured in Canada to customers in the U.S. The company also operates over fifteen fabricating plants in the U.S. Total corporation employment was about 65,400, of which 4,800 was the U.S. subsidiary.

Alcan's American subsidiary is organized into product divisions such as sheet and plate, ingots and metal powders, cable, building products, and secondary aluminum alloys. Major markets include building and construction, packaging and container industries, automobiles, appliances and farm equipment. Major automotive products supplied by Alcan include autobody sheet and primary and secondary aluminum. Alcan recently introduced a new alloy, Superplastic Aluminum Alloy, for automotive and truck body construction.

Sales for the total corporation Alcan Aluminum Ltd. have risen steadily over the past five years from $2.3 billion in 1975 to $4.4 billion in 1979. The U.S. subsidiary had sales of $1.1 billion, 26 percent of world sales. Corporation profits increased from $23 million in 1975 to $422 million in 1979. Subsidiary profits totaled $48 million in 1979, 11 percent of total company profits.

Alcan Corporation has reduced its debt to capitalization ratio from 40 percent in 1975 to 22 percent in 1979, despite an increase in long-term debt of $76 million in 1979. Capital expenditures were $450 million in 1979.

Alcan relies on its worldwide operations and its ability to expand its smelting and raw material operations into marketing strategy. The company is concentrating on increasing its production and sales of sheet and plate The growth of this market is being led by automotive, building, and can sales. An example of its expansion commitment is the new aluminum smelter in Grande Baie, Quebec. The first phase of the project will be completed shortly, costing about two hundred million Canadian dollars.

REYNOLDS METALS

Reynolds Metals is one of the five largest aluminum producers in the U.S. and world. The company supplies about 11 percent of the free world supply of aluminum. Sales in 1979 were $3.7 billion and profits were $177 million. About 84 percent of sales are for fabricated products. The company employed approximately 37,000 people in 1979.

Reynolds has separated its virtually integrated operations into two areas: (1) aluminum production and processing and (2) finished products and other sales. The company's major markets are packaging, building and construction, transportation, and the electrical manufacturing industry. The transportation market consumes about 12 percent of total sales, of which 8 percent is automotive related. Major automotive customers include General Motors, Ford and Chrysler. Major automotive products include primary aluminum, flat rolled aluminum sheet, fabricated specialty products, bumpers and face bars.

Company sales and profits have increased steadily over the past five years. Sales rose from $1.7 billion in 1975 to $3.3 billion in 1979 and profits climbed from $60 million to $177 million in 1979. Return on equity was 16.0 percent in 1979, more than double the return on equity of 7.6 percent in 1975.

Capital expenditures have increased significantly in the past four years, rising from $78 million in 1976 to $99 million in 1977, to $162 million in 1978 and to $230 million in 1979. Most of the 1979 expenditures were directed towards increasing sheet production. Despite increasing capital expenditures, Reynolds' debt to capitalization percentage declined from 50 percent in 1974 to 42 percent in 1979.

Reynolds' research and development and marketing strategies are focusing on expanding automotive markets. Reynolds spent $28.3 million in 1979 for basic and applied research and development activities. Current research thrust as applied to the auto community is to develop new applications for aluminum sheet and primary metals and to work closely with the major automakers to help them better understand the requirements and possibilities of casting aluminum engine blocks utilizing 390 aluminum without cast iron cylinder liners.

KAISER ALUMINUM AND CHEMICAL CORPORATION

Kaiser Aluminum and Chemical Corporation is one of the five largest aluminum companies in the U.S. The company is also involved in aluminum-related enterprises around the world, in chemical and refractory production and in other diversified undertakings. In 1979, Kaiser had record sales of $2.93 billion and earnings of $232 million.

The company has six primary operating divisions: raw and finished aluminum production, agricultural chemicals, industrial chemicals, refractories, trading and real estate. Aluminum accounts for 72 percent of corporate sales, followed by agricultural chemicals which accounts for about 9 percent.

Kaiser's major markets include electrical, building and construction, consumer durables, machinery and equipment, transportation and packaging. Approximately 11 percent of total sales goes to the transportation industry and about 4 percent of sales goes to the auto industry. Major automotive products include sheet, bar and ingots, plus fabricated products such as bumpers and forgings. Kaiser has four plants that supply to the auto industry.

Sales and profit have increased over the past several years. Earnings have grown steadily from $1.6 billion in 1975 to $2.9 billion in 1979. Profits have continuously increased from $45 million in 1976 to $232 million in 1979.

Kaiser's capital expenditures during 1979 amounted to $197.7 million, up from $185.8 million in 1978. The primary focus of expenditures was long-term modernization of existing plants. The company decreased its long-term debt obligations in four of the five years covering the period 1975-1979, the only exception being 1978, in which the company recorded an increase of $89 million. Kaiser's long-term debt to capitalization percentage was 38.4 percent in 1979, down from 44.2 percent in 1974.

ALUMAX INCORPORATED

Alumax is one of the ten largest aluminum producers in this country. It is an integrated producer of primary aluminum and fabricated aluminum products and is a wholly owned subsidiary of Amax Incorporated (50 percent), Metsui Company (45 percent) and Nippon Steel Corporation (5 percent). In 1979, company sales were $873 million and profits were $97 million.

Alumax divides its operations into seven major divisions. Six divisions focus on specific product lines while the seventh distributes Alumax's architectural products. Major markets include building and construction, packaging and transportation (recreational vehicles). Less than 1 percent of sales is to the auto industry. None of Alumax's plants serve the auto industry directly.

Alumax sales have grown steadily from $384 million in 1975 up to $873 million in 1979. Profits also increased steadily from $21 million in 1974 to $97 million in 1979. The company increased its long-term debt obligation by $105 million in 1979, compared to increases of only $33 million and $19 million in 1978 and 1979 respectively. Alumax's long-term debt to capitalization percentage was 20.6 percent in 1979, up from 16.9 percent in 1977.

Alumax is expanding its capacity and developing new products to meet increasing worldwide demand for aluminum. It recently completed an expansion program which increased its primary aluminum capacity by 68 percent. The company increased its shipments to the recreational vehicle market as a result of its development of a prepainted, striped RV paneling material to help manufacturers achieve economical brand identification.

APPENDIX G

SUMMARY PROFILES OF THE MAJOR FOUNDRIES WHO SUPPLY CASTINGS TO THE AUTOMOTIVE INDUSTRY

HAYES-ALBION

Hayes-Albion is one of the largest casting facilities in the U.S. Current ferrous casting capacity is 174,000 tons and non-ferrous casting capacity is 15,000 tons. Sales in 1979 were $254 million; 60 percent of the total was cast products. Profits in 1979 were slightly over $200,000. In 1979, the company employed about 4,800 people.

The company is organized into a Cast Products Group and a General Products Group. The latter group consists of an Automotive Fabricated Products subgroup which is responsible for fabricating various automotive products. The automotive industry is Hayes-Albion's largest single market accounting for 65 percent of total company sales. Ford is the most important customer, accounting for about one-third of total sales. Major cast iron products sold to the auto industry are transmission housings, universal yokes, disc brake calipers and rotors, rear axle housings, and front wheel hubs. Aluminum die cast products sold to the auto industry include fan spacers, power steering pump units, water pump bodies, and valve covers. The company's newest auto products are high volume permanent mold aluminum castings (e.g., intake manifolds) and ductile iron castings (e.g., brake calipers).

Sales have grown steadily in the last five years from $146 million in 1975 up to $254 million in 1979. Earnings of 200,000 and return on equity percentages of .3 percent in 1979 represented a decline compared to 1978 earnings of $9.3 million and return on equity percentage of 13.8 percent. Long-term debt obligations increased by $7.0 million and $2.4 million in 1979 and 1978 respectively. Long-term debt to capitalization percentage increased from 23.6 percent in 1978 to 29.8 percent in 1979.

Hayes-Albion's primary focus is on the automotive market. Auto downsizing is providing the company with the capability to expand its casting sales. The company sees lightweight castings as a major area of opportunity.

DAYTON MALLEABLE

Dayton Malleable Inc. is an independent foundry whose single business is the production of rough commercial castings made to customer designs and specifications. Patterns and tooling are owned by the customer. In 1979 sales were $184 million and profits were $3.1 million. The company employed about 3,140 people in 1979.

Dayton Malleable's main markets include: automobile and light truck, automotive air conditioning, medium and heavy truck, air conditioning and refrigeration, railroad, and farm and off-highway equipment. More than 30 percent of sales is to the automotive industry. Major customers include GM, Chrysler, Ford, Rockwell, Eaton, Mack Truck, White Motors, Carrier, and Caterpillar. GM accounts for 16 percent of sales and Chrysler accounts for 14 percent of sales.

Major automotive products made by Dayton include disc brake calipers, differential carriers and cases, front knuckle castings, air conditioning compressor housings, and steering gear housings. Dayton recently began producing nodular iron castings in one of its divisions. New automotive casting products include aluminum air conditioning compressors, aluminum manifolds, aluminum master cylinders, and nodular iron brake calipers. New products coming on stream in high volumes include calipers for Volkswagens and light trucks, spindles, automatic transmission drums and starters, and air conditioning compressor bodies.

Dayton's sales have fluctuated in recent years from $152 million in 1977, down to $143 million in 1978, and back up to $184 million in 1979. Earnings of $3.1 million and $2.2 million were low compared to 1977 earnings of $5.9 million. Return on equity percentages of 5.7 percent in 1979 and 4.1 percent in 1978 were also below the 1977 level of 11.3 percent.

Long-term debt obligations declined in 1978 and 1979 by about one-half million in each year. The company's long-term debt to capitalization percentage also declined from 4.3 percent in 1977 to 3.4 percent in 1978 and to 2.5 percent in 1979.

LYNCHBURG FOUNDRY

Lynchburg Foundry, a pioneer in shell mold casting in the 1940s, is a major ductile and gray iron producer of small castings. The Foundry is a part of the Industrial Manufacturing Group of Mead Corporation. The Foundry had sales of roughly $120 million in 1979, or over half of total sales for the Industrial Manufacturing Group. The Foundry employed about 4,500 people in 1979.

The automotive market accounts for 50 percent of the Foundry's sales. Although the company supplies to all of the major U.S. auto manufacturers, major work is done for Ford and Chrysler. Major auto products include disc brake calipers, power steering housings, automotive transmission drums, front wheel spindles and valve housings.

Lynchburg Foundry's marketing strategy is to maintain its strong position in the small castings market, to increase its penetration in the medium castings market which is identified as a high growth market and to avoid the large castings market. Small castings are primarily used for automotive vehicles, air conditioning and farm machinery, while medium castings primarily serve the construction equipment, trucking and farm machinery industries. Large castings primarily serve the process equipment and machine tool markets.

CWC-TEXTRON

CWC Castings, a division of Textron Corporation, is a major gray iron foundry in the state of Michigan. Total production is approximately 200,000 tons per year. Sales were about $150 million in 1979, down 12 percent from the previous year's sales of $170 million. The company employed about 3,200 persons in 1979.

CWC's major markets are farm and agricultural equipment, marine, automotive, truck, air conditioning, and electrical products and appliances. About 25 percent of the castings goes to the passenger auto industry. CWC makes all the camshafts for General Motors' cars except the Chevrolet, and all the camshafts for American Motors. Manifolds are sold to Ford, Chrysler and American Motors.

In lieu of entering the aluminum casting business, CWC has expanded its product range in iron and has introduced ductile iron capability. CWC is promoting thin wall castings, high strength gray iron castings, and ductile iron castings as alternatives to aluminum automotive manifolds.

DOEHLER-JARVIS

Doehler-Jarvis of NL Industries is one of the largest casters of zinc, aluminum and magnesium in the U.S. The company is also the largest custom die caster in the world and has expertise in other component making technologies such as permanent and semi-permanent mold casting and various types of machining and assembling. Sales in 1979 were $217.7 million, about 12 percent of NL Industries' total sales. Doehler-Jarvis employed about 7,000 people in 1979.

Doehler-Jarvis' principal market is the automotive industry which accounts for more than 50 percent of its sales. Other markets include appliance, power tool and office equipment manufacturers. Die cast aluminum auto products include rack and pinion steering housings, automatic transmission parts, and windshield wiper parts. Steering column housings for tilt steering mechanisms are magnesium die cast. Intake manifolds, master brake cylinders, and cylinder heads are permanent and semi-permanent mold cast aluminum. Zinc castings are now usually decorative parts.

Doehler-Jarvis only recently began using semi-permanent and permanent mold casting for aluminum. This has allowed it to make automobile parts such as cylinder heads or intake manifolds. Die casting, however, remains the largest part of the business.

The auto industry changes are having a direct influence on Doehler-Jarvis' strategy. With the trend toward use of lightweight materials in automobiles, Doehler-Jarvis is making two important marketing moves. The first is to pursue the aluminum casting market for automotive parts and components. Next, it is withdrawing from the zinc die casting market.

WHELAND FOUNDRY

Wheland Foundry is a large caster of gray iron with virtually all of its sales directed toward the auto industry. Sales in 1979 were $108.8 million, up from $86.5 million in 1978, and the foundry employed about 1,400 people. Wheland is a division of North American Royalties, Inc., and accounts for 92 percent of that company's sales.

In 1979, nearly 90 percent of Wheland's sales were accounted for by five companies: General Motors (Chevrolet), Ford, Motor Wheel Corporation, Kelsey-Hayes and the Budd Company. Wheland's major products are disc brake rotors, brake drums and automatic transmission castings. Approximately 85 percent of castings are for brake parts and 15 percent are for transmissions. North American Royalties' strategy is to continue to expand gray iron sales, while also expanding its oilfield operations to be less dependent on the automotive market. Despite automobile downsizing, the company sees little effect on the sales of the particular parts it manufactures.

The company has had substantial sales and earnings growth in the last six years. In 1979 earnings were 9.3 percent of sales and return on equity was 16.5 percent. The company's ratio of debt to capitalization has decreased from 42 percent in 1974 to 9 percent in 1979.

Wheland recently completed a $3.25 million expansion program, increasing total division capacity by 8 to 10 percent.

AUTOMOTIVE SPECIALTIES

Automotive Specialties Manufacturing Company (AUSCO) is an important supplier of malleable auto components to the auto industry. Sales in 1979 and 1978 were about $50 million. The company employed about 1,365 people in 1979..

The major markets for AUSCO are automobile, truck, farm equipment, aircraft, and machinery manufacturers. Virtually all casting sales are to the automotive, truck, and off-road vehicle industries. Key customers in the automotive industries are: Chrysler (differential carriers and cases); American Motors; Eaton (truck parts); Rockwell; Warner Gear (cases and yokes); Ross Gear (cases and yokes); Kelsey-Hayes (brake components); Budd; and Dana.

Major automotive products include differential carriers and cases, brake calipers, yokes and power steering parts. The company is mainly a malleable iron foundry, but recently has begun to make ductile iron products.

AUSCO sees automobile downsizing as a significant threat to its malleable iron market. Recently, it added the capability to produce ductile iron, an alternative to malleable casting. Ductile iron is in some respects a cheaper, lighter material than malleable. This move is hoped to counter the weakening malleable market. The company is also developing new products for markets outside the auto industry such as rail or electrical industries.

COLUMBUS FOUNDRIES INCORPORATED

Columbus Foundries is a relatively new corporation started in 1971 and is now one of the largest ductile iron foundries in the country. Sales for the privately held company were about $39 million in 1979 up from about $33 million in 1978. The company employed about 1,000 people in 1979.

The company supplies castings to the following markets: construction equipment, materials handling, heavy truck, automotive, agricultural equipment, power transmission and utilities. Approximately 50-55 percent of sales go to the auto industry. Major customers are Dana, Chrysler, Bendix, and Simpson which account for 38 percent of sales. Major automotive products are disc brake caliper housings, spring hangers, and steering gear housings. Only ductile iron castings are made.

Columbus seeks continued growth in the ductile iron market and promises to continue to grow with its customers. In order to maintain sales to the auto industry, the company is aggressively bidding on castings for cars that are perceived to be strong competitors in the 1980s. The company recently started producing parts for the Ford Fairmont series and the GM X-body cars.

APPENDIX H

SUMMARY PROFILES OF THE MAJOR SUPPLIERS OF PLASTICS

MONSANTO

Monsanto has the second largest U.S. capacity in ABS, an important automotive plastic. Company sales in 1979 were $6.2 billion, of which $1.4 billion was due to plastics and resins. Approximately 16 percent of company sales is to the auto industry. Monsanto employs 64,000 people.

Monsanto sees the automotive market as a growth area for its sales of Lustran ABS and SAN and Vydyne (nylon thermoplastic). New grades of these plastics were introduced in 1979, broadening the application and potential markets for these lines. Monsanto expects most of its growth in the 1980s to come from existing businesses.

Monsanto's plastics business has decreased operating income each year since 1977. Although the automotive plastic, ABS, continues to sell well, the entire plastics division has had problems because of low margins and because of losses associated with the company's Spanish subsidiary. The entire company has also had declining earnings, with earnings as a percent of sales declining from 9.2 percent in 1974 to 5.3 percent in 1979. In 1979 return on equity was 12.4 percent. Monsanto increased its debt in 1975, 1977 and 1978, but has maintained its debt to capitalization ratio near historic levels at 28 percent.

Monsanto's research and development efforts have produced a new low-cost process for producing ABS. According to Monsanto, when commercialized, this new process will enhance the company's competitive position in the sales of ABS.

BORG-WARNER

Refer to the profile of Borg-Warner in Chapter 2—Parts and Components Suppliers (page 2-30).

UNION CARBIDE

Union Carbide is the leading producer of urethane intermediates, which are used in automotive seat foam, bumpers and carpeting. Sales in 1979 were $9.1 billion of which $3.4 billion was due to chemicals and plastics sales. Union Carbide employs 64,000 people in the United States and 50,000 people overseas.

Union Carbide has developed and promoted reaction injection molding technology for urethane. This process has already increased the use of the plastic in automotive fascia and energy absorbing bumpers. Urethane formulations are now available for potential use in large body parts such as fenders, hoods, deck lids and body panels. Union Carbide is also a major supplier and researcher in graphite fiber composites and hopes to develop a large market for these in the automotive industry.

Union Carbide has had widely fluctuating earnings over the past five years. In 1979 earnings were 6.1 percent of sales. Return on equity was 14.4 percent, up from 11.2 percent in 1978. The company increased its debt in 1975, 1976 and 1979 and has maintained its debt to capitalization ratio near 27 percent.

Union Carbide has developed a new process to produce polyethylene that is supposed to require only a quarter of the energy of existing technologies. By 1982 the company should have a billion pounds per year capacity to produce polyethylene by its new process. Polyethylene is used for a few automotive parts, such as insulation of electrical wiring and seat belt casings.

MOBAY

Mobay Chemical Corporation, whose parent is Bayer AG of Leverkusen, Germany, was formed in 1954 to introduce polyurethanes to America. The venture was formed as a 50-50 partnership with Monsanto (hence the name Mobay). However, in the 1960s the Federal Government required Monsanto to sell its interest in Mobay to Bayer, alleging that the joint ownership of Mobay violated antitrust laws. Today Mobay has become the nation's largest manufacturer of polyurethane raw materials and polymers. Sales in 1979 were $.96 billion and the company had about 6,000 employees.

Mobay's polyurethanes are used in automotive foam, bumpers and fascia. The company also makes a polycarbonate which is used in certain automotive components requiring engineering plastics. Mobay is working on fiber-reinforced urethane for further automotive applications.

Mobay's sales and earnings have been increasing markedly in recent years. Return on equity was 18.4 percent in 1979 compared to 9.5 percent in 1976. In 1979 earnings were 6.1 percent of sales. Mobay has funded its capital expenditure from internal cash flow, equity from Bayer AG and increases in long-term debt.

Mobay has recently been significantly expanding its capacity to produce urethane intermediates.

HERCULES

Hercules is the largest domestic producer of polypropylene, one of the major automotive plastics. Sales in 1979 were $2.3 billion and the company employed 24,400 persons, 19,600 of whom were in the United States.

Polypropylene is sold by Hercules in both bulk and upgraded form, with about 60 percent of the business in upgraded products. There are three main types of upgraded products: film, Herculon olefin fibers used in commercial and automotive carpet and copolymers used in such items as automotive battery cases. Two products Hercules feels should result in increased sales to the auto industry in the 1980s are Herculon fibers and polypropylene-steel automotive panels. The panels have the appearance and properties of steel but weigh 40 percent less.

Hercules wishes to avoid overdependence on any particular cyclical market and feels it was too dependent on space and defense in the 1960s and textiles in the 1970s. The company is thus actively seeking greater penetration in the automotive market. The company has also set a goal of changing its sales mix more toward highly processed polypropylene products than toward basic resins.

Hercules had some poor years from 1975-1977, but now profits are rebounding. Return on equity was 19.6 percent in 1979 compared to 7.7 percent in 1977, and 1979 earnings were 7.4 percent of sales. Hercules has reduced its debt as a percent of capitalization from 34 percent in 1974 to 21 percent in 1979.

AMOCO

Amoco (Standard Oil of Indiana) is one of the largest corporations in the United States and also a major producer of polypropylene and high-density polyethylene. Sales in 1979 were $20.2 billion and $2.6 billion of this was attributed to the Amoco Chemical Corporation, the group that produces the plastics. The entire company employs 46,000 people domestically and 52,000 people worldwide. About 10-15 percent of Amoco's resin sales are to the auto industry.

The most common automotive applications for Amoco's polypropylene are fan shrouds, battery cases, glove boxes, fender liners, air conditioner ducts, rear lamp housings and battery trays. Amoco Chemical's overall strategy for plastics is to continue improving its penetration into "higher margin" specialty market areas such as the automotive market. Amoco notes, however, that this will become increasingly difficult as other companies—such as Phillips and Gulf—begin manufacturing and marketing polypropylene for automotive consumption.

Earnings from Amoco Chemical Corporation have fluctuated with the chemical industry. Earnings in 1979 rose to $202 million from $45.5 million in 1978. The entire company had a return on equity of 19.2 percent in 1979. The ratio of long-term debt to capitalization for the company decreased from 30 percent in 1975 to 21 percent in 1979.

B.F. GOODRICH

B.F. Goodrich is the largest domestic manufacturer of polyvinyl chloride (PVC) used in a variety of automotive products, such as car upholstery. Sales in 1979 were $3.0 billion and the company employed approximately 41,000 people.

Besides PVC, Goodrich also sells urethanes, elastomers and tires to the auto industry. Goodrich recently entered a joint venture with Cosden Oil and Chemical Company for the manufacture and marketing of Abson ABS thermoplastics. Goodrich sees long-term growth in polyvinyl chloride demand and plans to double its PVC capacity to 2.3 billion pounds a year to match a projected doubling of PVC demand.

B.F. Goodrich has had fluctuating earnings in recent years. Earnings were 2.8 percent of sales in 1979 and return on equity was 9.2 percent. The company has decreased the percentage of debt to capitalization from 38 percent in 1974 to 30 percent in 1979.

DUPONT

DuPont is a major supplier of plastics to both the auto industry and the auto suppliers. The company had $12.6 billion in sales in 1979, with approximately 20 percent of this going to the auto industry. The company employs approximately 134,000 people.

DuPont offers a wide range of engineering plastics used in door handles, lamp lenses, bushings, bumper guards, carpet, tire cord, cable liners, windshield interlayer film, and many other areas. It has long been DuPont's overall corporate goal to market a product line well downstream from raw materials—products where the value added is high. Thus, research and development is an important part of the company. A 1978 reorganization elevated the importance of research and development by putting it under the direct responsibility of a corporate vice president who sits on the executive committee.

DuPont has had strong earnings over the last few years. Earnings were 7.5 percent of sales in 1979 and return on equity was 19.3 percent. In 1979 long-term debt was only 15.6 percent of capitalization. At the same time capital expenditures were $860 million or 10.2 percent of total assets. The company feels it will be able to continue capital expenditures at this level over the next few years without additional borrowing.

GENERAL ELECTRIC

General Electric began its plastics business as part of a search for insulating materials that could meet the demand for new electrical applications. From that start, General Electric (GE) has become a pioneer in the area of engineering plastics. Total company sales were $22.5 billion in 1979 and the plastics business accounts for an estimated 2 percent of corporate sales. Total company employment is 405,000 people.

General Electric has a unique set of engineering plastic products which are given the brand names Lexan, Noryl, Valox and Genal. All are used in the automotive market. Of the four major engineering plastics used in automobiles, GE manufactures three of them (all except nylon) and is the sole supplier of one of them (Noryl). The company recently introduced Arnox, a high-strength, durable engineering plastic specifically introduced for automotive use. GE is also continuing research into the use of its plastics in bumpers, dashboards, windows and headlamps.

General Electric has been earning consistently good profits in recent years. Earnings were 6.3 percent of sales in 1979 and return on equity was 20.2 percent. The company's debt to capitalization ratio is a low 11.2 percent.

To serve automotive and other customers of Lexan polycarbonate, GE is investing $80 million in incremental stages at its Mount Vernon, Indiana, plant to increase polycarbonate capacity by 35 percent.

GENERAL TIRE & RUBBER COMPANY

General Tire is a leading supplier of processed plastic parts to the auto industry. Sales in 1979 were $2.3 billion and chemicals and plastic sales comprised about 20 percent of total sales and 30 percent of operating income. Total employment is 42,000 people.

According to the company, General Tire's Chemicals/ Plastics Division is the world's largest manufacturer of supported and unsupported vinyl fabric materials, much of which is used in automobiles. The company also claims to be the largest supplier of fiberglass-reinforced plastic (FRP) parts, such as the body panels for the Corvette, and various grilles, hoods and fender skirts on other cars. General Tire is a leading supplier of polyurethane foam and flexible molded foam for automotive seating and padding applications. General Tire presently sees the automotive fiberglass-reinforced plastic market as a prime area for market growth. This is especially important since the tire industry has been declining in recent years due to the introduction of radials. GTR Reinforced Plastics Company was formed in 1978 to help strengthen General's position as a major producer of FRP parts.

General Tire has had large increases in sales in recent years, but operating margins have fallen. The company has had some success in increasing its earnings through diversification—tires and related products account for only 44 percent of sales and 35 percent of earnings. In 1979 earnings were 3.6 percent of sales and return on equity was 8.4 percent. The company has decreased the percentage of long-term debt to capitalization from 33 percent in 1974 to 20 percent in 1979.

DAVIDSON RUBBER DIVISION OF EX-CELL-O CORPORATION

A well-established manufacturer of machine tools and other industrial equipment, Ex-Cell-O merged with McCord Corporation in 1978, thereby greatly diversifying its operations into the automotive supply community. Davidson Rubber Division of McCord is now Ex-Cell-O's largest automotive products division. Ex-Cell-O's total sales in 1979 were $.96 billion and the company's Automotive Components segment, of which Davidson Rubber is a division, accounted for about one-quarter of sales and operating profits of the corporation.

Davidson's major automotive products are soft urethane bumpers, reaction-injection-molded urethane front and rear fascias, padded instrument panels and armrests and interior and exterior trim. Davidson supplies about 45 percent of all soft bumpers used in 1980 model cars and the company sees significant growth in this market over the next few years.

Ex-Cell-O has had strong sales and increasing margins in all of the last five years. In 1979, earnings were 5.6 percent of sales and return on equity was 16.2 percent. The ratio of the company's debt to capitalization was 14.4 percent in 1979.

To meet the growing demand for flexible fascias, a new reaction injection molding line and a new paint line were installed at Ex-Cell-O's Americus, Georgia, plant.

APPENDIX I

SUMMARY PROFILES OF THE DOMINANT GLASS AND FIBERGLASS SUPPLIERS

PPG

PPG is the largest supplier of flat glass in the country, the second largest supplier of glass to the automotive industry and a major supplier of fiberglass. Sales in 1979 were $3.1 billion. The company has about 38,000 employees and gains about 15 percent of its revenues from sales to the auto industry.

PPG's sales to the automotive market are derived largely from its production of glass windshields and side glass, plastic-fiberglass composite components and resins, and various automotive coatings and finishes. Although PPG basically supplies flat glass to Detroit and plastic resins to plastic fabricators who in turn produce finished components, the company is attempting to market to Detroit an increasing volume of fabricated products such as the injection-molded front-end components it produces for Chrysler.

PPG has had variable results in the last few years although earnings reached record levels in 1979. In that year, earnings were 7.1 percent of sales and return on equity was 17.4 percent. The ratio of debt to capitalization has been fairly steady over the last six years and is now at 25.5 percent.

PPG is building a plant in Evansville, Indiana, that will be the company's first automotive glass plant to fabricate both laminated glass windshields and tempered glass side and rear windows.

LIBBEY-OWENS-FORD

Libbey-Owens-Ford (LOF) is the largest supplier in the country of flat glass for use in automobiles and the second largest supplier for use in building construction. Sales in 1979 were $1.2 billion. The glass division accounted for about 50 percent of sales and 40 percent of operating earnings, while the plastic subsidiary accounted for 12 percent of sales and 10 percent of earnings. The company employs about 21,000 people.

There are two major groups at LOF that supply to the auto industry. The Glass Division makes flat glass and supplies two-thirds of the glass requirements of General Motors (about one-third of LOF's total sales). LOF Plastics, Inc., makes fiberglass-reinforced plastic parts for the auto industry. LOF has diversified significantly since the 1960s when almost all of the company's revenues came from glass manufacturing. In the 1980s the company feels there will be a large increase in its sales of plastic products to the auto industry.

LOF has faced slightly declining margins in the last four years. Earnings were 4.8 percent of sales in 1979 as opposed to 6.8 percent in 1976. In 1979 return on equity was 13.6 percent. LOF increased its debt in 1979, increasing its debt to capitalization ratio from 15.9 percent to 24.3 percent. This was accompanied by major increases in capital expenditures. Recent capital expenditures were connected, in part, with the company's expenditure of $60 million to enlarge its total float glass capacity by 25 percent.

OWENS-CORNING FIBERGLAS CORPORATION

Owens-Corning Fiberglas Corporation, founded in 1938, is the world's largest manufacturer of glass fiber products. Sales in 1979 were $2.2 billion. The company employs 26,500 people and approximately 10 percent of its sales are to the auto industry.

The major automotive products shipped by Owens-Corning are fiberglass reinforcements used in tires and various automotive plastics. Owens-Corning is developing fiberglass and resin systems ideally suited for different areas of the car, from cosmetic parts to structural applications. The company is also developing advanced processing machinery to mold its new resin systems into a variety of automotive parts.

Owens-Corning has been very successful as demand has increased for its fiberglass products. In 1979, earnings were 4.9 percent of sales and return on equity was 15.5 percent. The company has significantly increased its capital expenditures in the last few years. Nevertheless, long-term debt is still only 18.9 percent of total capitalization. In 1979, the major capacity expansion was the completion of Phase I of a new glass fiber reinforcements plant at Amarillo, Texas.

APPENDIX J
REPORT OF NEW TECHNOLOGY

The contents of this report contain no patentable material.

200 copies

U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
TRANSPORTATION SYSTEMS CENTER
KENDALL SQUARE, CAMBRIDGE, MA. 02142

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF TRANSPORTATION
513