DOT HS-803 963

RT PASSENGER AUTOMOBILE WEIGHT PROJECTIONS 1979-1986 MERCEDES-BENZ, BMW, VOLVO, BL LTD.

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Contract No. DOT HS-7-01789
Contract Amt. $15,650.00

DEPARTMENT OF TRANSPORTATION • UNITED STATES OF AMERICA

NOVEMBER 1978

FINAL REPORT

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

Prepared For

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Washington, D.C. 20590

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 803 963		

4. Title and Subtitle
Import Passenger Automobile Weight Projections
1979-1986
Mercedes-Benz, BMW, Volvo, BL Ltd.

5. Report Date
November 1978

6. Performing Organization Code

7. Author(s) Theodore Taylor, Jr.; Madelyn C. Isaacs; Katherine E. Blythe.

8. Performing Organization Report No.

9. Performing Organization Name and Address
Corporate-Tech Planning Inc.
275 Wyman Street
Waltham, Massachusetts 02154

10. Work Unit No.

11. Contract or Grant No.
DOT-HS-7-01789

13. Type of Report and Period Covered
FINAL REPORT
August - October 1978

12. Sponsoring Agency Name and Address
U.S.Department of Transportation
National Highway Traffic Safety Administration
400 7th Street, SW
Washington, DC 20590

14. Sponsoring Agency Code

15. Supplementary Notes
Technical Monitor: William Basham, Code NRD-13, Technology Assessment Division, Office of Passenger Vehicle Research, National Highway Traffic Safety Administration.

16. Abstract
A preliminary analysis is presented for projecting curb weights of automobiles for four import manufacturers -- Mercedes-Benz, BMW, Volvo, BL Ltd. These manufacturers may have difficulties meeting U.S. fuel economy standards for the 1978 through 1985 model year period due to their limited offering of luxury and or sports vehicles with low fuel economy ratings. An overview of their product plans, financial and production status was developed from publicly available sources, highlighting fuel economy efforts. Even with expanded use of diesel engines (development of which is subject to stricter emissions standards) and turbochargers, substantial weight loss would probably be needed to meet legislated goals. An analysis of potential weight reduction through the mid-1980's was performed based on engineering analysis and the manufacturer's known product plans to the extent available. Individual manufacturer's strategies of weight loss due to 1) all new vehicle design, 2) major sheet metal change, and 3) component redesign and material substitution were formulated, drawn in part from weight reduction successes achieved by U.S. manufacturers. Results are presented at the detail level by manufacturer and model and at the summary level by series and EPA market class. Weight loss potentials from eleven to thirty-two percent (depending on vehicle size and engine type) were estimated from 1978-1986.

17. Key Words
Weight Reduction, Import Autos
Mercedes-Benz
Volvo
BMW
British Leyland/BL Ltd.

18. Distribution Statement

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	152	

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

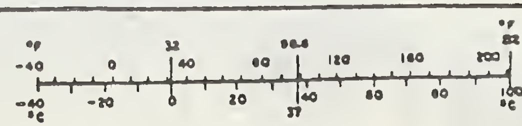
METRIC CONVERSION FACTORS

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		
in^3	cubic inches	16.4	cubic centimeters	cc
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
L	liters	61.02	cubic inches	in^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report was prepared for the U. S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) and presents results of an analysis of the weight reduction capabilities of four European auto manufacturers (Mercedes-Benz, BMW, Volvo, and BL Ltd.) who may have difficulties meeting the Corporate Average Fuel Economy (CAFE) standards through the mid-1980's. Sponsored by NHTSA's Office of Passenger Vehicle Research, this analysis provides support to the Passenger Automobile Standards Division of the Office of Automotive Fuel Economy Standards (OAFES) in the development of the fuel economy rule support paper.

Since the fuel economy ratings of all four companies are restricted to a few high priced luxury or "sports" cars, additions, replacements, or modifications to current models offered would be required in order to raise the fleet average to the levels legislated for the 1980's. The short period between 1979 and 1985 precludes implementation of radically new engine designs and alternative power systems. The most feasible improvements are those based on technology currently available or in advanced development stages in the areas of weight reduction, aerodynamic drag, turbocharging, and diesel engines, although continued diesel development is subject to potentially stricter U.S. emission standards.

This report contains profile descriptions compiled from publicly available information, to present an overall perspective of each company's product plans, financial and production status, highlighting actions to improve corporate and vehicle fuel economy ratings. Results indicate that each company plans expanded use of diesel and turbocharged engines but so far they have announced few specific weight reduction programs.

Since weight reduction offers these manufacturers the greatest fuel economy benefits, an engineering analysis was conducted of the potential for weight reduction through 1986.

Strategies for each vehicle series were formulated combining the weight reduction techniques of complete vehicle redesign, use of smaller engine/driveline combinations, and component alterations through material substitution and parts redesign. It is anticipated that many weight reduction successes of U. S. auto manufacturers, particularly with component changes, would be equally beneficial to the import manufacturers. Results are presented at the detailed level by manufacturer and model and at the summary level by market class.

Appreciation is acknowledged for the guidance and assistance provided by Mr. William Basham who served as DOT Technical Monitor for this study, and to Mr. Robert Kost of NHTSA's Passenger Automobile Standards Division.

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LIST OF ABBREVIATIONS

AE	Automotive Engineering
AI	Automotive Industries
AMM	American Metal Market Metalworking News Edition
AN	Automotive News
AR	Annual Report
AVL	Anstart Feur Verbrenningsmotoren

BL	British Leyland
BMW	Bavarian Motor Works
CAFE	Corporate Average Fuel Economy
CID	Cubic Inch Displacement
CIS	Continuous Injection System
CTP	Corporate-Tech Planning INc.
DM	Duetsche Mark
DOT	Department of Transportation
EPA	Environmental Protection Agency
FI	Fuel Injection
FWD	Front-wheel-drive
L(ℓ)	Liter
£	British Pound
MB	Mercedes-Benz
MPG	Miles Per Gallon
NVMA	Motor Vehicle Manufacturers Association
NHTSA	National Highway Traffic Safety Administration
R&T	Road and Track
Skr	Swedish krona
VDO	Vereinigte Deuta OTA
VW	Volkswagen
WAR	Ward's Automotive Reports
WAW	Ward's Auto World
WEU	Ward's Engine Update
WSJ	Wall Street Journal
ZF	Zahnradfabrik Friedrichshaten

1. INTRODUCTION AND SUMMARY

All foreign auto manufacturers exporting vehicles for the United States market must comply with the United States fuel economy, emissions and safety standards designated for model years 1978-1985. Currently, the average European car imported to the United States satisfies the 1980 and 1981 CAFE requirements of 20 and 22 miles per gallon. While a number of individual production models meet or exceed the 1985 CAFE requirement, such as the diesel version of the Volkswagen Rabbit which has a combined fuel economy rating of 45 miles per gallon, no manufacturer's current corporate average achieves the 1985 CAFE requirement of 27.5 miles per gallon.

Alternatives available to meet the CAFE regulations are restricted by the lead times required to develop and implement new technologies. Application of new engine designs and alternative power systems are, therefore, not feasible for the short-term period from 1979-1985. Instead, the European companies are concentrating on weight reduction techniques, expanded use of diesel and turbocharged engines, and vehicle designs which incorporate aerodynamic principles. For example, substitution of lightweight plastic, aluminum and high strength steel for mild steels, and improved vehicle body and chassis design, all contribute towards weight reduction. Volkswagen has estimated that a ten percent reduction of the aerodynamic drag coefficient could result in a 3.5 percent fuel saving. The majority of European manufacturers already offer or are developing diesel and/or turbocharged engines which achieve higher fuel economy ratings than comparable sized gasoline engines. However, until a clearer picture of diesel emissions and subsequent standards are achieved, continued diesel engine development will be subject to risk.

This report focuses on four European car manufacturers who may have difficulty meeting the CAFE requirements for the United States Market, due to their limited product offerings. These manufacturers are Mercedes-Benz, BL Ltd. (formerly British Leyland), Volvo, and BMW. A problem common to all four companies is that their primary markets are high priced luxury or "sports" cars with low fuel economy ratings. Unlike their American counterparts who have greater market diversity upon which to average out fuel economy ratings, these four importers are handicapped with fuel economy ratings restricted to a very few models.

The objectives of this study were to provide NHTSA with an analysis of potential vehicle weight reductions through the mid-1980's for these four manufacturers based on engineering analysis and publicly available information, as well as an overall perspective of each company's product plans, financial and production status.

This report contains:

1. A profile on each manufacturer consisting of descriptions of current product lines and U.S. sales; worldwide manufacturing facilities including assembly and component plants; future technology, vehicle product plans; and financial status. An overview of the independent component supplier industry in Europe is also provided with specific reference to these four companies where data was available.
2. Projected curb weights for 1978-1986 by model for each manufacturer, which reflect potential weight reduction which these auto manufacturers could incorporate by 1986 based on today's product plans and technology advances.

1.1 Methodology

The weight reduction analysis employed four major steps as illustrated in Figure 1-1:

a. Establishment of 1978 baseline weights for each model;

b. Assessment of vehicle weight reduction methodologies such as: vehicle redesign, component weight changes, and engine changes;

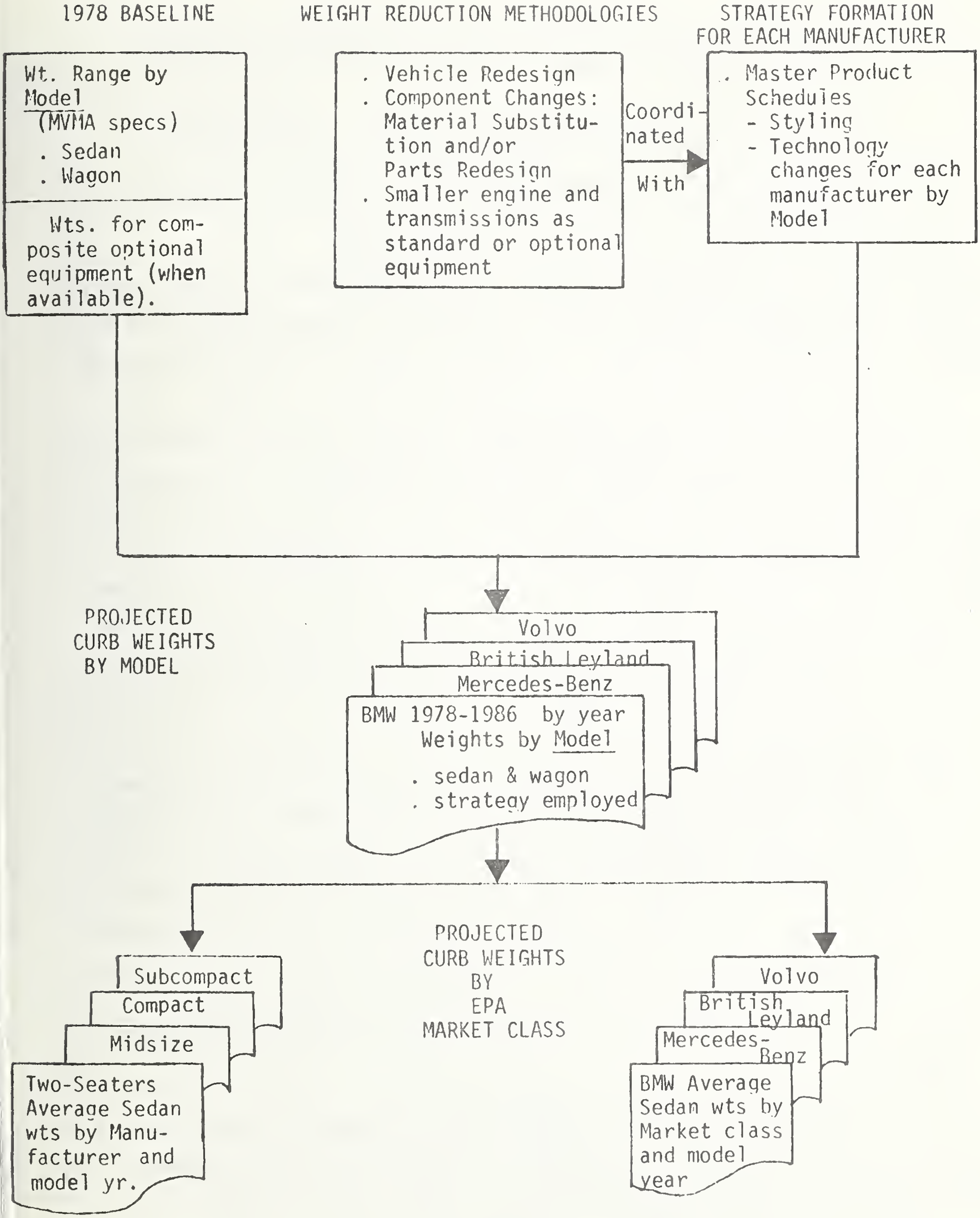

FIGURE 1-1. ANALYSIS METHODOLOGY FOR IMPORT PASSENGER AUTOMOBILE WEIGHT PROJECTIONS

c. Formulation of specific weight reduction strategies to be employed by each manufacturer;

d. Projection of curb weights by model. Arrangement of vehicle weight data by EPA Market Class and the determination of arithmetic average weights of sedans for each market class and manufacturer.

Curb weights were projected by model employing the strategies forumulated for each manufacturer. These strategies involve the manufacturers' known plans for new model introductions, downsizing, substitute materials and other technology advances.

Certain qualifications and guidelines were used in order to expedite the analysis. Current models are assumed to be available in the U.S. through 1986, unless announced plans indicate otherwise. It was felt desirable to use the EPA Market Classification so the results could be related to the EPA/DOE Consumer Mileage Guide. Current EPA classifications (based on volumetric measures) are retained through 1986; however, caution must be exercised in using EPA classifications since models may shift classes from one year to the next.

All information was derived from publicly available sources. Much of the methodology developed in the weight reduction analysis of U.S. domestic manufacturers was employed in this analysis of import manufacturers. However, this analysis indicates feasible actions which could be taken by these importers -- not emphatically what they would do -- since definitive product plans are not fully known. The focus here is to identify resources which could be employed in the event of a shortfall in meeting CAFE requirements.

1.2 Profiles

The analysis indicated that although the import manufacturers were concentrating efforts on expanded use of diesel and turbocharged engines and heavy investment in plants and equipment to expand product lines and output, few specific weight reduction programs have been announced. BL and Volvo have recently negotiated extensive aid packages with the governments of Britain (BL) and Norway (Volvo) and the Netherlands (Volvo) to finance future development.

All four companies emphasize diesel development programs. Mercedes expects diesel sales to exceed 53% to meet 1978 CAFE requirements; Volvo will introduce diesel sedans and wagons to the U.S. in 1980; BMW and Volvo are also developing turbocharged engines for introduction in the 1980's. BL's diesel efforts are currently restricted to the home market, due to financial problems incurred by the car division.

Each company will introduce new models in the near future. BMW and Mercedes each plan a lower priced model with improved fuel economy ratings which would not cannibalize sales of the higher priced models. There have been no reports to indicate that two new BL models in the planning stage (a mini and midsize vehicle) will be exported to the United States.

Vehicle weight reduction efforts so far have been minimal primarily to avoid: 1) risking loss of rideability from severe downsizing, which is a major marketable feature of these cars; and 2) high engineering costs entailed in redesigning suspension to preserve the same rideability, if vehicle weights were reduced significantly. However, in view of the annually increasing fuel economy standards, substantial weight reduction programs may still be necessary even with expanded use of diesel engines.

The role and structure of the independent component supplier industry in Europe was analyzed. Substantial data was compiled on the major suppliers within each country (West Germany, France, Italy, and Britain). Major products, parent company (including home country if part of a conglomerate), and some important customers were identified. Restrictions to OEM/supplier and supplier/supplier relationships by country, which depend on local anti-trust regulations, were assessed. New supplier market opportunities beyond traditional national borders have developed as worldwide cars, with parts manufactured in different countries, gain prominence. For the U. S. market, import auto makers and suppliers must share the cost to develop technology and production facilities to meet U. S. fuel economy, emissions, and safety standards. Exchange of technology between U. S. and European firms proliferate, contrary to general impression here. In addition to exporting components, U. S. firms are expanding European subsidiaries; European suppliers with expertise in front-wheel-drive and small car design find increased opportunities in the U. S. market.

1.3 Projected Curb Weight Analysis

Weight reduction offers the greatest payoff towards attaining fuel economy goals, and can be achieved through complete redesign of vehicles, routine styling changes, use of smaller engine/driveline combinations, and component alterations through material substitution and parts redesign. Although import manufacturers have announced few specific weight reduction programs, all have some plans to expand production and use of lighter weight components. Based on the success of lighter weight component applications by U.S. manufacturers, it is anticipated that import manufacturers will avail themselves of technology advances in this area.

Strategies available to each manufacturer are summarized in Table 1-1. Major vehicle redesigns and major sheet metal changes reflect reported weight loss projections. The preponderance of asterisks in Table 1-1 reveals that few definitive major vehicle changes have been announced. As a result, most of the estimated weight loss was derived from token weight losses which include component changes, smaller engine/driveline combinations, and changes in standard or optional equipment offerings which may be implemented on a more piecemeal basis independent of major styling changes. The differences in estimated token weight losses among manufacturers and between each manufacturer's series reflect differences in vehicle size, engine type (diesel or spark ignition), and whether major changes have been announced, as discussed in Sections 7.3 and 7.4.

TABLE 1-1

IMPORT WEIGHT LOSS STRATEGIES

MANUFACTURER	WEIGHT LOSS STRATEGIES: Major Vehicle Redesign	Major Sheet Metal Change (%)	Token Weight (lbs./yr)
Mercedes-Benz			
Spark Ignition	11½% + token weight	5%	90-100
Diesel	11½% + token weight	2.5%	55-75
BMW			
3 and 4 Series	*	5.5%	75
5, 6, and 7 Series	*	5.5%	100
British Leyland			
MG, Triumph, Rover	*	*	50
Jaguar	*	*	150
Volvo			
240 Series	*	*	110
260 Series	*	*	125
Diesels	*	*	110

* No announced plans.

The total weight loss attainable by 1986 is a function of economic as well as technological factors. Therefore, this analysis focused on probable model by model alterations using technology currently available or expected to be implemented by 1986 rather than maximum theoretical weight loss which could be achieved by vehicle engineering and redesign alone. Ultimately, a point is reached where the cost of redesign and material selection outweighs weight reduction benefits derived. This point is reached well before a manufacturer has fully exploited all weight reduction options open to him.

The analysis results are summarized in Table 1-2. Using the individual manufacturer's net reduction strategies shown in Table 1-1, weight losses from 11-32% (depending on vehicle size) were estimated, with the majority of vehicles in the 21-27% range. By 1986, the average vehicle for each of these manufacturers could weigh less than 3000 pounds. Slightly more weight is expected to be removed from higher weight classes with poorer fuel economy ratings since they would benefit most. For any of the intervening years before 1986, larger weight differences within a manufacturer's product lines do exist because of the difference in product timing and strategies employed. Since these manufacturers' vehicles do not necessarily compete head-to-head in the marketplace, it is more important to view the results of each manufacturer's efforts independently.

The results indicate that the weight reduction changes offer an attractive strategy towards achieving the fuel economy goals, if the manufacturers choose to pursue it. Manufacturers' ability to comply with the goals is further enhanced if diesel (and turbocharged) engines continue to be accepted both by the coming public and EPA emissions standards; and if financial and technological resources remain available to expand vehicle offerings and engine improvements.

TABLE 1-2

PROJECTED WEIGHT REDUCTION
BY MANUFACTURER

MANUFACTURER	SERIES	EPA MARKET CLASS	% WT LOSS 1978-1986	AVG. WT. 1978 (LBS)	AVG. WT. 1986 (LBS)	Δ WT 1978-1986 (LBS)
Mercedes-Benz	107	Two-Seater	25	3838	2893	945
	123/170	Compact	22	3409	2650	719
	116	Compact	22	3895	3045	850
	116V	Midsize	27	4235	3110	1125
BMW	3, 4	Subcompact	24	2650	2013	637
	5	Subcompact	26	3440	2550	890
	6	Subcompact	27	3360	2450	910
	7	Compact	24	3800	2900	900
Volvo	240	Compact	23	2926	2266	660
	260	Compact	21	3141	2474	667
British Leyland	MG, Triumph	Two-Seater	11	2117	1884	233
	Jaguar	Subcompact	27	3936	2886	1050
	Jaguar, Rover	Compact	32	4201	2867	1334

2. MERCEDES

2.1 Introduction

Mercedes-Benz, the second largest West German passenger car producer (behind Volkswagen), is West Germany's most successful manufacturer of large luxury cars. Mercedes is also a major supplier of diesel cars, and offered the world's first production passenger diesel car in 1936 with the introduction of the 260D. Since then, there has always been at least one diesel-powered car in the Mercedes model line.

During the 1977 fiscal year, Mercedes continued to expand production, sales and profits. Corporate earnings increased 13.5 percent, passenger car production by 8.3 percent, and car sales (in millions of DM) by 10 percent over 1976 figures. Mercedes' high quality, expensive passenger cars appeal to a market less likely to be influenced by cyclical economic conditions; therefore, economic adversity will have less effect on Mercedes sales than on other companies, as evidenced by Mercedes uninterrupted growth throughout the 1970's (including 1974/75 recession).

To meet increased vehicle demand, Mercedes has begun major capital improvements in manufacturing facilities. Management, however, is cautiously avoiding excess capacity in view of the uncertain growth potential for the worldwide automotive industry.

Mercedes' future research programs concentrate on problems related to U.S. fuel economy, emissions, and safety standards. Plans include: 1) further development of diesel engines (which constituted 46% of 1977 U.S. sales), turbocharged engines, catalytic converters, and passive restraint systems; 2) research into diesel emission controls and alternative power systems; and 3) implementation of weight reduction programs, primarily light-alloy engines and selected body components.

2.2 Corporate Financial Profile

Mercedes' total passenger car production in 1977 was 401,255 units, an increase of 8.3 percent from 370,348 units in 1976. Since

1971, car production has increased 41.2 percent. Consolidated sales for the company increased by 10 percent in 1977 to 25.9 million DM.

Mercedes' capital investment program for both the foreign and the domestic markets amounted to 1.1 billion DM in 1977. The 1978-1982 capital spending program contains 7 billion DM of domestic investment primarily to strengthen Mercedes' international competitiveness and to expand car market line and output. This substantial capital commitment necessitated a broadening of Mercedes' financial base. In December 1977, the capital stock was raised by 170 million DM to 1,359 million DM. Mercedes' allocation to research and development increased 33 million DM in 1977, compared with the 22 million DM increase in 1976.

Net income for 1977 was 445 million DM, a gain of 13.5 percent from the 1976 net income of 392 million DM. Increased car sales and production, a decrease in depreciation expenses of 60 million DM, and an increase in net interest income to 160 million DM were contributory factors.

Table 2-1 highlights the Mercedes financial data for 1971-1977. Daimler-Benz of North America, Inc. is the United States importer, whereas Mercedes-Benz of North America, Inc. is the United States distributor. Passenger car sales in the U.S. market, increased 13 percent from 43,235 units in 1976 to 48,872 units in 1977. Mercedes held 2.2 percent of the U.S. import market (ranking tenth) and 0.4 percent of the total U.S. market (ranking fourteenth) in 1977. Total U.S. sales in 1977 valued 2.15 million DM, a 20.3 percent increase from 1976 of 1.79 million DM. The percentage increase was somewhat restrained by delivery delays of limited production models, such as model 300SD. Mercedes-Benz of North America projects 1978 sales of 45,000, an 8 percent decrease compared to 1977 sales. The most recent sales figures in August 1978 indicate an 11.2 percent decrease in units from August 1977. The decrease is due partly to a West German metalworkers strike in early 1978 resulting in a 25,000 production loss, as well as to a loss of U.S. sales because of the severe winter weather.

TABLE 2-1. DAIMLER-BENZ FINANCIAL HIGHLIGHTS

Number of Employees (at year-end)	1971	1976	1977
Daimler-Benz Group. Domestic (1)	119,029	126,652	131,807
Consolidated (2)	146,996	160,863	169,165
of which: Domestic	127,391	132,676	138,042
Foreign	19,605	28,187	31,123
Production (in units)			
Passenger cars	284,230	370,348	401,255
of which: Intermediate Class (3)	189,076	262,062	278,411
Upper Intermediate Class (4)	34,452	35,188	37,736
Hi-Line (5)	60,702	73,098	85,108
Commercial Vehicles (excluding major components)	188,095	247,756	248,100
of which: Domestic Plants	159,677	193,204	187,298
Foreign Plants	28,418	54,552	60,802
Sales (6) Values in millions of DM			
Consolidated	12,740	23,503	25,864
of which: Domestic Sales	7,239	10,407	11,719
Foreign Sales	5,501	13,096	14,145
of which:			
export by domestic companies	3,832	9,465	9,954
value added by foreign subsidiaries (7)	1,669	3,631	4,191
Daimler-Benz Group, Domestic	10,625	19,358	21,146
of which: Domestic Sales	6,852	10,165	11,444
Export Sales	3,773	9,193	9,702

(1) Daimler-Benz AG and Hanomag-Henschel Fahrzeugwerke GmbH consolidated from 1969 on.

(2) Daimler-Benz AG plus domestic and foreign subsidiaries with more than 50% ownership. (The figures of the Moloren Und Turbinen-Union and of Merfag AG are included each with 50% in accordance with our ownership interest therein) Euclid, Inc. Cleveland, U.S.A. acquired in 1977 is included for the first time.

(3) Models 200-250 and 200D, 300D

(4) Models 280-280E, 230C-280CE and 300 CD

(5) Models 280S-450SEL 69 and 280SL-450SLC5.0

(3)–(5): In the previous years the corresponding models.

(6) Including value added tax.

(7) Conversion to DM.

Source: Annual Report 1977.

TABLE 2-1. DAIMLER-BENZ FINANCIAL HIGHLIGHTS (CONCLUDED)

DAIMLER-BENZ AG

Value in millions of DM	1971	1976	1977
Assets			
Current	2,256	5,745	6,882
Fixed	2,263	2,261	2,397
Total Assets	4,519	8,006	9,279
Liabilities and Shareholders' Equity			
Capital Stock	761	1,189	1,359
Retained earnings	988	1,182	1,412
Shareholders' Equity	1,749	2,371	2,771
Long and Medium-Term Liabilities	991	2,014	2,403
Other Liabilities	1,779	3,621	4,105
Total Liabilities and Shareholder Equity	4,519	8,006	9,279
Net Income for the year (in millions of DM)	207	392	445
% of Daimler-Benz Group Domestic Sales	1.9%	2.0%	2.1%

2.3 Manufacturing Facilities

All passenger car production included in the consolidated corporate statements occurs in company-owned plants in Germany, which are described in Table 2-2. Worldwide, there are nine production plants and twenty-eight assembly plants manufacturing Daimler-Benz passenger cars and commercial vehicles. Many passenger car components are shipped from the Sindelfingen plant to foreign plants for assembly. Where governments maintain rules on local content of vehicles, as in South Africa, some components must be assembled there for local use.

In 1977, Mercedes initiated a medium term capital spending program for domestic plants directed towards increasing passenger car production and improving efficiency through further integration of individual plants. A budget equivalent to $2.5 billion has been appropriated for a three year period through the end of 1979 with total expansion costs for the next five years projected at $3.5 billion (including a new gearbox plant for heavy vehicles). Mercedes' expansion objectives include production of 450,000 cars a year by 1983, an increase of 1,000 a week over present capacity.

In Germany, a new assembly plant will build the factory designated W201 model, scheduled for introduction to the domestic market in 1982.

There are no plans for Mercedes to build a U.S. assembly plant. According to the president of Mercedes-Benz North America, the plant would have to be limited to producing a single model.

2.4 Current Product Line and Sales

Mercedes-Benz currently offers twelve models to the U.S. market. Given Mercedes' system of model code designation, any variations between vehicles because of engine size or type or vehicle configuration (coupe or sedan) constitute separate models, with new model codes. Different model numbers for the slightest changes create what appears to be a large list of models when, in fact, differences are not that pronounced. Table 2-3 presents an overall perspective

TABLE 2-2. MERCEDES-BENZ DOMESTIC MANUFACTURING PLANTS*

Passenger Car Assembly

Plant	Scope of Activities	No. Employees (1977)
Singelfingen	Body and Assembly Plant all models	34,359
Bremen	Body and Assembly Plant T-Series	4,727 (1)

Passenger Car Component Plants

Plant	Scope of Activities	No. Employees
Untertuerkheim	Engine production; Forge, Stamping of Components and Chassis Parts, Passenger Car Repair	12,916
Mettingen	Axle Fabrication, Foundry, Parts Manufacture and Depot	6,525
Hedelfingen	Transmission Fabrication	2,859
Bruehl	Exchange Engine Assembly	858
Zuffenhausen	Engine Parts and Components, Exchange Transmission and Axle Assembly	792
Bad Homburg	Engine Valve Train Components	736
Duesseldorf	Steering Units	4,664 (1)
Berlin-Marienfelde	Parts	3,065 (1)
Hamburg-Harburg	Chassis and Components	2,265 (1)
Other Plants	Commercial Vehicle Components and Assembly; non-passenger engine plants	57,056
Administration, Research and Development at Untertuerkheim		7,220
Total Domestic Employment		138,042

(1) Includes commercial vehicle activities.

*Data not available on production rates or capacities.

SOURCE: 1977 Annual Report p. 40

TABLE 2-3. MERCEDES U.S. MODEL LINE: SELECTED 1978 SPECIFICATIONS

WHEELBASE (inches)	ENGINE 2.3L (IL-4)	DIESEL 2.4L (IL-4)	2.8L (IL-6)	DIESEL 3.0L (IL-5)	4.5L (V-8)	6.9L (V-8)	
96.9					450SL 2-dr. 2 seat Convertible CW=3815 MPG=14		
106.7			280CE 2-dr. Coupe CW=3510 MPG=16	300CD 2-dr. Coupe CW=3495 MPG=25			- W107
110	230 4-dr. Sedan CW=3195 MPG=19	240D 4-dr. Sedan CW=3210 MPG=29 Man. Trans.	280E 4-dr. Sedan CW=3530 MPG=16	300D 4-dr. Sedan CW=3515 MPG=25			
111					450SLC 2-dr. Coupe CW=3960 MPG=14		
112.8			280SE 4-dr. Sedan CW=3905 MPG=16	300SD 4-dr. Sedan CW=3885 MPG=26 Turbo			- W116
116.5						450 6.9 4-dr. Sedan CW=4390 MPG=12	
116.7					450 SEL 4-dr. Sedan CW=4080 MPG=14		

NOTES:

Unless otherwise specified, all models are equipped with gasoline engine and automatic transmission as standard equipment.

CW=Curb Weight (lbs.)
MPG= Combined Miles Per Gallon (per EPA Gas Mileage Guide 2nd ed., 1978).
Man. Trans.= Manual Transmission
Turbo=Turbocharged Engine

W123 Series

W107 Series

W116 Series

by series such that individual models can be compared. A complete list of 1977 vehicles with production statistics and U.S. sales data is contained in Table 3-4. Engine size is usually designated by the first two digits of the model code (i.e., 28 = 2.8 liter engine), except for the 450 SEL 6.9 which has a 6.9 liter engine. D = diesel; E = fuel injected; S = full size; C = coupe; T = touring.

The latest U.S. sales figures through August 1978 indicate Mercedes sales of 30,311, approximately equal to the sales of the eight month period last year when 30,145 units were recorded. Mercedes-Benz expects 1979 U.S. sales to reach 50,000 of which 60 percent will be diesels.

230

Equipped with a 4-cylinder engine, 2-barrel carburetor and 3-speed automatic transmission, the 230 4-door sedan retails at $13,972. 1977 sales in the United States of 1,097 accounted for 2.2 percent of the total U.S. Mercedes market. In comparison, 1976 sales figures of 1,248 represented 2.9 percent of total U.S. Mercedes sales. 1978 sales through August totalled 460 units.

240D

Introduced to the United States in 1973, the 240D 4-door sedan is equipped with a 4-cylinder, fuel-injected diesel engine and a choice of 4-speed manual or automatic transmission. The 240D is the most inexpensive Mercedes model retailing at $12,762. 1977 sales in the U.S. of 10,548 accounted for 21.6 percent of Mercedes' total U.S. market. In comparison, 1976 sales figures of 7,359 represented 17.0 percent of total U.S. Mercedes sales. Worldwide sales figures for this model have also increased by 8.8 percent from 37,107 units in 1976 to 40,382 in 1977. 1978 sales through August totalled 5,031 units.

280CE

The 280CE 2-door coupe is a 1978 replacement for the 280C and is the coupe version of the 280E sedan. Equipped with 4-speed automatic transmission and the same 2.8 liter fuel-injected, 6-cylinder engine used in the 280E 4-door sedan, the coupe retails

TABLE 2-4. MERCEDES-BENZ PASSENGER CAR LINE

Model	Engine/Transmission	Price	Total (1) 1977 Production	U.S. Sales (2) August, 1978 Year-to-Date	U.S. Sales (3) Total 1977
U.S. Import Models					
230 Sedan	L-4 2bbl., 3A	$13,972	52,910	460	1,097
240D Sedan	L-4, FI, 4M/3A (Diesel)	12,762	40,382	5,031	10,548
280 CE Coupe	L-6, FI, 4A	22,141	33,171 (a)	2,308	341 (e)
280E Sedan	L-6, FI, 4A	18,348			4,173
280SE Sedan	L-6, FI, 4A	21,687	45,278 (b)	2,632	4,491
300D Sedan	L-5, FI, 4A (Diesel)	19,120	49,683	7,131	11,619
300CD Coupe	L-5, FI, 4A (Diesel)	19,987		1,461	267
300SD Sedan	L-5, FI, 4A (Diesel)	23,878	51	1,192	1978 Intro.
450SEL Sedan	V-8, FI, 3A	27,131	14,265 (c)	4,022	6,586
450SEL 6.9 Sedan	V-8, FI, 3A	41,444	1,798	301	462
450SL Convertible	V-8, FI, 3A	24,725	12,688	5,773	7,180
450SLC Coupe	V-8, FI, 3A	13,000			1,788
Tourist Deliveries					4,946
Miscellaneous					320
Other Models Not Exported to U.S.					
200			39,112		
200D			56,378		
220D			19,323		
250			25,183		
280SL			2,971		
350SE			6,530		
350SL			1,472		
250T/280TE/300TD			5 (d)		
			401,200		

(1) Auto News 4/24/78 p. 53.

(2) Mercedes Benz North America Sales Dept.

(3) Ward's Auto Yearbook 1978, p. 53.

(a) Includes 280 model, not exported to U.S.

(b) Includes 280S model, not exported to U.S.

(c) Includes 450 SE model, not exported to U.S.

(d) 1979 U.S. introduction expected

(e) Includes 280 C model.

Key:

L-4	= 4-cylinder engine.
L-6	= 6-cylinder engine.
V-8	= V-6 engine.
FI	= Fuel injection.
2bbl.	= 2 barrel carburetor.
4M	= 4 speed manual
3A/4A	= 3/4 speed automatic

at $22,141. 1977 sales of 341 accounted for 0.7 percent of the total U.S. Mercedes market. 1978 sales through August totalled 916 units.

280E

The 280E 4-door sedan is equipped with a 6-cylinder, fuel-injected engine and automatic transmission, and retails at $18,348. 1977 sales in the U.S. of 4,173 accounted for 8.5 percent of the total U.S. Mercedes market. In comparison, 1976 sales figures of 2,745 represented 6.2 percent of total U.S. Mercedes sales. Worldwide sales figures for this model have decreased by 4.1 percent from 34,599 units in 1976 to 33,171 in 1977. 1978 sales through August totalled 1,392 units.

280SE

Equipped with a 6-cylinder, fuel-injected engine and automatic transmission, the 290SE sedan retails at $21,687. 1977 sales in the United States of 4,491 accounted for 9.2 percent of the total U.S. Mercedes market. In comparison, 1976 sales figures of 2,594 represented 6.0 percent of total U.S. Mercedes sales. Worldwide sales of this model have increased 22.2 percent from 37,041 units in 1976 to 45,278 in 1977. 1978 sales through August totalled 2,732 units.

300D

The 300D 4-door sedan is equipped with a 5-cylinder, fuel-injected diesel engine and retails at $19,120. The 300D is the best selling Mercedes model in the U.S. with sales of 11,619 accounting for 23.8 percent of all Mercedes models sold in the U.S. in 1977. In comparison, 1976 sales figures of 9,544 representing 22.1 percent of total U.S. Mercedes sales again accounted for the highest share of Mercedes models sold in the U.S. The company is hoping to capitalize on the 300D's success by introducing a coupe version. 1978 sales through August totalled 7,131 units.

300CD

Introduced to the United States in late 1977, the 300 CD 2-door coupe was the first Mercedes diesel coupe to enter the market.

Equipped with the same 5-cylinder, fuel-injected diesel engine as the 300D and a 4-speed automatic transmission, the 300CD retails at $19,987. Diesel sales represented up to 47 percent of the U.S. Mercedes market in 1977 with projections of 55 percent for 1978. The 300CD, built exclusively for the U.S. market, had sales of 267 units in 1977 and accounted for 0.5 percent of the U.S. Mercedes market. 1978 sales through August totalled 1,461 units.

300SD

The 300SD 4-door sedan, introduced to the United States in mid-1978, was the first turbocharged diesel production car to enter the market. Sharing the same body as the 280SE, the 300SD is equipped with a 5-cylinder, fuel-injected diesel engine, a Garrett turbocharger and automatic transmission. Built exclusively for the U.S. market, the model is available on a limited basis with 4,000 units produced this year and 9,500 units projected for 1979. The model will be marketed as a full size car with improved fuel economy and will retail at $23,878. Its EPA combined rating of 26 mpg is the highest of all models. 1978 sales through August totalled 1,192 units.

450SEL

The 450SEL sedan is equipped with a V-8 fuel-injected engine and 3-speed automatic transmission, and retails at $27,131. 1977 sales in the United States of 6,586 accounted for 13.5 percent of the total U.S. Mercedes market. In comparison, 1976 sales figures of 4,925 represented 11.4 percent of total Mercedes U.S. sales, 1978 sales through August totalled 4,022.

450SEL 6.9

Introduced in 1977 to the United States and equipped with a 6.9 liter V-8 fuel-injected engine and 3-speed automatic transmission, the 450SEL 6.9 sedan is the most expensive Mercedes model, retailing at $41,444. 1977 sales in the U.S. of 462 accounted for 0.9 percent of the total U.S. Mercedes market. Worldwide sales figures for this model have increased by 21.9 percent from 1,475 in 1976 to 1,798 in 1977. 1978 sales through August totalled 301. This model will be dropped after 1979 due to poor fuel economy ratings.

450SL

Equipped with a V-8 fuel-injected engine and 3-speed automatic transmission, the 450SL convertible retails at $24,725. 1977 sales in the U.S. of 7,180 accounted for 14.7 percent of the total U.S. Mercedes market. In comparison, 1976 figures of 5,893 represented 13.6 percent of total Mercedes U.S. sales. Worldwide sales figures of this model have increased by 21.7 percent from 10,427 in 1976 to 12,688 in 1977. 1978 sales through August totalled 4,469.

450SLC Coupe

Introduced in 1973 to the United States with an 8-cylinder, fuel-injected engine and 3-speed automatic transmission, the 450SLC coupe retails at $13,000. 1977 sales in the U.S. of 1,788 accounted for 3.7 percent of the total U.S. market. In comparison, 1976 sales figures of 1,578 represented 3.6 percent of total U.S. Mercedes sales. 1978 sales through August totalled 1,304.

2.5 Future Technology

Mercedes research and development emphasizes environmental protection, fuel economy, and vehicle safety.

Mercedes is currently researching alternative fuels, particularly in the sareas of hydrogen fuel and hydrogen as an additive to gasoline. There are several advantages to using hydrogen fuel: it can be produced relatively inexpensively in unlimited quantities (with the aid of coal or nuclear energy), is virtually emission-free, and does not require new engine technology to use it.

Tests have been run on a Mercedes city bus equipped with a four-cylinder, 2.3 liter engine using pure hydrogen. The bus uses a metal-hydride storage system which absorbs hydrogen at low temperatures and sheds it at higher temperatures. (Energy diverted from the exhaust or cooling system helps heat the hydrides and release the gas). Heavier hydrides and more energy are needed to release the gas at low temperatures (as in cold startups) than at high temperatures. A combination of so called "low temperature" and "high temperature" hydrides can give ranges up to 250 miles for a hydride weight of 440 pounds. Mercedes projects that the primary energy efficiency rate could be raised from under 20 percent to over 50 percent.

Mercedes is also running tests on a 280E sedan using a mixture of hydrogen and gasoline. Hydrides would be most effective for startup and short distance driving. For full load operations on the open road, gasoline would be used alone. Gasoline engines are easily adapted to run on a hydrogen/gasoline mixture and produce a clear exhaust, with only minimal levels of oxides of nitrogen (NO_x).

Until the United States Environmental Protection Agency (EPA) publishes standards on acceptable diesel emissions and particulates, Mercedes' increasing reliance on diesels to meet U.S. CAFE requirements causes uncertain degrees of risk. Although measurement and control of diesel particulates are problems common to all, no solutions exist for particulates control. Mercedes is also experiencing difficulties with existing EPA standards on NO_x. The company has expressed its belief that diesel powered vehicles in the 3,500 to 4,000 lbs. weight class cannot meet the NO_x requirement of 1.0 grams/mile in 1985. Mercedes suggests that the limit be held to 2.0 grams/mile and that special emission standards be set for heavier diesel cars, similar to those set in Germany, Sweden and Australia.

Between 1980 and 1981, Mercedes plans to sell 2,250 cars equipped with airbags for the driver and with the standard three-point safety belt system for the passenger. The company has volunteered to cooperate with the United States Department of Transportation in field testing passive restraint systems and is working on improvements for the three-point safety belts for other markets.

Research is continuing into noise reduction for engines, components and vehicles.

2.6 Vehicle Product Plans

Mercedes' efforts to meet 1985 U.S. fuel economy standards focuses on increased use of diesels and turbocharged gasoline and diesel engines. However, in view of the increasing emission standards and potential limits of consumer acceptance of diesels, Mercedes is also working on more efficient vehicle designs to supplement its current product lines for the 1980's.

Mercedes and Steyr-Daimler-Puch of Austria are jointly building a four-wheel drive light vehicle similar to a Jeep or Land Rover.

With more concentrated diesel marketing effort, diesel penetration is expected to be 55% for 1978, 60% for 1979, 63% for 1981, and 70% for 1982 when the 24 mpg CAFE becomes effective. Mercedes claims that an upper limit below the 70% penetration for 1982 would necessitate: weight reduction greater than a feasible 15%; limiting sales in the U.S.; accepting $5,000 or more penalty per car and adding it to the price tag; and reducing vehicle performance to less than acceptable levels. A 27% weight reduction would be needed for each unit with a 50/50% gasoline/diesel engine mix (presumably to meet 1985 CAFE standards).

In early 1979, Mercedes will introduce in the U.S. a 5-cylinder diesel powered 300TD station wagon.

Weight reduction on existing models has been directed towards lightweight material application for selected components rather than from overall vehicle size reduction which Mercedes feels would adversely impact vehicles' marketability. Mercedes has reduced the weight of its domestic 450SLC 5.0 liter coupe model by installing a 5-liter spark ignition V-8 engine made from a Reynold's high silicon aluminum alloy using a design which does not require cylinder liners (a 4.2 kg/92 lb. weight reduction); and some lighter alloy body panels (deck lid, and hood) and wheels for a total weight savings of 100 kg (220 lbs.) over the standard model.

Projected product plans beyond 1980 do include reduced vehicle dimensions and weight, but to a much lesser extent than projected for U.S. auto manufacturers.

An improved fuel economy four-wheel drive subcompact sedan (factory designated W201) will be introduced in Germany in 1982, and later exported to the U.S. to compete against the BMW 3 series market. The W201, with a probable model designation of '170', will have passenger space comparable to current 123 series (230/240D/280E/300D) but will weigh at least 430 pounds less. It will have a wheelbase of 102 inches and overall length of 173 inches in comparison to the current 230/240D/280E/300D model measurements of 110 inch wheelbase and 190.9 inch length. Standard engine will be 1.7 liter 4-cylinder with optional 2-liter 4-cylinder, 2.3 liter 6-cylinder, and 2 diesel options. Diesel versions may be built in collaboration with Steyr-Daimler-Puch of Austria.

In 1981, Mercedes will replace the current 116 series (280SE, 450SEL, 450SLC, 450-6.9L) with a smaller 126 series of cars powered by lighter weight 6 and 8 cylinder gasoline engines and turbo-charged diesel engines. A 3-way catalyst and continuous fuel injection will be fitted on the gasoline engines. The 6 and 8 cylinder cars will also have a 4-speed automatic transmission with increased acceleration. Body styles will feature a lower and wider grille, rubber and plastic bumpers with chrome inserts, improved aerodynamics and weight savings of approximately 450 pounds.

In 1982, Mercedes' 4-cylinder gasoline engines will be fitted with 3-way catalyst systems and continuous fuel injection. A turbo-charged version of the 4-cylinder diesel engine is planned for 1983. There is also speculation that the company will introduce an additional turbodiesel by 1985.

Between 1982 and 1984, the 450SL sport version will be replaced by a smaller version which will have aluminum front and rear decks and a lighter weight engine like the sedans.

In 1985, the downsized, lightweight successors to the 123 series (230, 240D, 280E, 300D, 280CE, and 300CD) will be introduced to the U.S. market in both turbo-diesel and gasoline versions. The gasoline engine construction will be either all-aluminum or thin-wall cast iron with an aluminum cylinder head. Mercedes projects that aerodynamic efficiency will be increased by 5 percent, as will transmission efficiency.

One scenario of projected average combined fuel economy of Mercedes vehicles expected to be sold in the U.S. for model years 1981-1986 is displayed below.

		MODEL YEAR			
		1981	1982	1983/1984	1985
123/124 Series	With smaller diesel	29.7	29.7	30.6	33.1
	With intermediate diesel				34.9-35.6
	With larger diesel	27.6	27.6	30.4	33.5
	With 4-cyl. gas engine	19.5	20.5	22.0	23.5
	With 6-cyl. gas engine	17.6	17.6	19.7-20.2	22.6-23.0
126 Series	With diesel	28.3	28.3	28.3	28.3-29.0
	With 6-cyl. gas engine	17.8	17.8	19.9-20.3	19.9-20.3
	With smaller 8-cyl. gas engine	17.3	17.3	18.8-19.1	18.8-19.1
	With larger 8-cyl. gas engine	12.5	12.5	17.3	17.3
126/107/129 Series	Coupe, roadster, both with smaller 8-cyl. engine	17.4	17.4	19.0-19.4	19.0-19.4
		17.4	17.4	19.5=20.0	19.5-20.0
U.S. Fleetwide Fuel Economy Standards		22 MPG	24 MPG	26/27 MPG	27.5 MPG

Source: Automotive News 12/26/77 p. 27.

2.7 References

MERCEDES

CORPORATE FINANCIAL PROFILE

Annual Report 1977	p. 1, 12, 15, 17, 25, 51, 66, 67.	
Wards Auto World	6/78	p. 43
	11/78	p. 27
Wards Automotive Yearbook	1977	p. 41, 53
Wards Engine Update	11/10/78	p. 2

MANUFACTURING FACILITIES

Annual Report	1977	p. 43
Automotive News	3/20/78	p. 76
Road & Track	2/78	p. 54
Wards Automotive Reports	5/29/78	p. 173

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Automotive News	12/26/77	p. 6
U.S. Dept. of Transportation Transportation Systems Center West European Auto Industry		p. 8
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Wards Engine Update	7/7/78	p. 8

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Automotive News	4/24/78	p. 18
	5/29/78	p. 4
	8/28/78	p. 11, 13
	10/23/78	p. 1
Road & Track	1/78	p. 38, 40
	7/78	p. 78
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Automotive Engineering	3/78	p. 14
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	4/3/78	p. 2
	6/26/78	p. 48
Motor Trend	7/78	p. 22
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Wards Auto World	6/78	p. 49
Wards Automotive Reports	1977	p. 106
Wards Engine Update	7/7/78	p. 8

3. BAVARIAN MOTOR WORKS

3.1 Introduction

BMW (Bavarian Motor Works), the smallest of the West German auto manufacturers, is currently expanding both capital spending and automotive production. Increased demand for BMW cars spurred a 20% annual corporate growth rate in the mid-1970's. The 4.5% growth rates for 1977 and 1978 (projected) reflect insufficient production capacity for certain popular models as well as corporate intentions to consolidate resources so the growth rate stabilizes at around 10% in the 1980's. Models currently offered are displayed in Table 3-1.

In the U.S., BMW posted record sales in 1977 of 28,500 vehicles, a 10% increase over 1976 sales. Sales for the first eight months of 1978 are 9.5% higher than the comparable period in 1977; total 1978 U.S. sales expect to be 16% higher than total 1977 with the introduction of the 733i model.

BMW is actively pursuing programs to improve vehicle fuel economy in view of U.S. 1985 CAFE requirement of 27.5 miles per gallon. Efforts concentrate on new model introductions, development of fuel efficient engines (diesel, turbocharged and a direct injection four-stroke diesel), and, to a lesser degree, implementation of a weight reduction program.

3.2 BMW Corporate Financial Profile

BMW plans to produce about 300,000 cars in 1978, a 4.5% increase over 1977 production of 288,000. In contrast to other auto makers, BMW weathered the 1974 recession rather well. Its domestic sales during 1974 dropped only modestly while foreign sales actually maintained the 1973 level; sales growth during 1975 and 1976 actually exceeded 20%. 1977 sales grew 4.5%. BMW is attempting to "consolidate" resources and hopes to stabilize growth at about 10% annually, as illustrated in the chart on Page 3-3.

TABLE 3-1. BMW PASSENGER CAR PRODUCTION PROGRAM

Passenger Cars

	316:	1573cc, 66 DIN kw (90 hp)
	318:	1766cc, 72 DIN kw (98 hp)
①	320:	1990cc, 90 DIN kw (122 hp)
	323i:	2315cc, 105 DIN kw (143 hp)
	518:	1766cc, 66 DIN kw (90 hp)
	520:	1990cc, 90 DIN kw (122 hp)
	525:	2494cc, 110 DIN kw (150 hp)
⑤	528i:	2788cc, 130 DIN kw (177 hp)
②	530i:	2986cc, 130 DIN kw (176 hp)
	530 Sudafrika:	2986cc, 135 DIN kw (184 hp)
③	630CS:	2986cc, 136 DIN kw (185 hp)
④	633CSi:	3210cc, 147 DIN kw (200 hp)
	728:	2788cc, 125 DIN kw (170 hp)
	730:	2986cc, 135 DIN kw (184 hp)
	733i:	3210cc, 145 DIN kw (197 hp)

Total production 1977 = 290,236 units.

① exported to U.S. since late 1976, with fuel injection.

② U.S. version, exported since 1975. Will be replaced by 528i in 1979.

③ exported to U.S. in 1977 only, with fuel injection.

④ introduced to U.S. in Spring 1978.

⑤ to be exported to U.S. in 1979 (Automotive News 10/16/78, p.1).

Source: Annual Report 1977 p. 14 and 15.

BMW plans to invest heavily into new plants and tooling. In 1978, almost $200 million will be invested, compared with $165 million in 1976 and $170 million in 1977. The company will invest $17.5 billion over the next five to six years, 40% of that total supporting new product development. Since BMW has only recently introduced its new range of cars, new models are not expected until 1980; however, by 1985, the whole range will need to be reviewed.

BMW established BMW of North America in Montvale, New Jersey, as a subsidiary in 1975 after buying out Hoffman Motor Corporation, who served as importer and U.S. distributor prior to 1975. Since then the number of U.S. dealers has grown from 250 to 335, with sales per dealer increasing to 93 from 50 over the past three years. BMW AG capital holdings in BMW of North America totalled $4 million in 1976; its capital holdings in BMW (U.S.) Holding Corporation in Delaware totalled $8 million in 1976.

Although BMW's 1977 U.S. sales increased 10% over 1976 sales figures (from approximately 26,000 in 1976 to 28,500 in 1977), its total share of the U.S. import market dropped to 1.4% in 1977 from 1.7% in 1976 since total U.S. imports sales were up 39% in 1977 (to about 2,100,000 from 1,500,000 in 1976). In 1977, BMW held 0.3% of the total U.S. market and ranked 12th in sales among the imports and 16th among all manufacturers.

Calendar Year	Total Sales		U.S. Sales	
	# Vehicles	% Yearly Increase	# Vehicles	% Yearly Increase
1974	184,330			
1975	227,000	23%	19,500	
1976	275,000	21%	26,000	34%
1977	288,000	4.5%	28,500	10%
1978 (projected)	300,000	4.5%	33,000	16%
1979 (projected)		10%	37,000	12%

Table 3-2 presents BMW financial information for 1977.

TABLE 3-2. BMW ASSET AND CAPITAL STRUCTURE

Assets	Dec. 31, 1977 DM Mill	Dec. 31, 1976 DM Mill	Liabilities	Dec. 31, 1977 DM Mill	Dec. 31, 1976 DM Mill
Tangible Fixed Assets	1,123.7	1,015.0	Net Worth	820.5	695.6
Financial Assets	262.6	201.7	Long Term Borrowed Capital	711.7	582.2
Fixed Assets	1,386.3	1,216.7	Capital Employed	1,532.2	1,277.8
Inventories and Advance Payments Made	449.0	341.5	Earmarked Reserves	477.7	394.0
Trade Debtors	173.0	116.1	Trade Creditors and Advance Payments Received	324.5	288.9
Liquid Funds	218.4	189.6			
Accounts Receivable From Associated Companies	198.8	183.1	Accounts Payable to Associated Companies	83.9	93.0
Other Current Assets	156.5	145.3	Other Short-Term Liabilities	98.4	75.6
Current Assets	1,195.7	975.6	Dividends Payable	65.3	63.0
			Short-Term Liabilities	1,049.8	914.5
Balance Sheet Total*	2,582.0	2,192.3	Balance Sheet Total	2,582.0	2,192.3

*After allowing for the general provision for bad debt.

Source: 1977 Annual Report

3.3 Manufacturing Facilities

BMW operates three passenger car production and assembly facilities in Germany and one in South Africa as described in Table 3-3. Most components used in South African produced vehicles are shipped from Germany, others are produced locally. BMW is reportedly so pleased with the price and quality of South African produced components that it is considering exporting some to Germany.

As previously noted, BMW planned high investments of $200 million for new plants and tooling in 1978. One reason for the relatively high expenditure is to correct a backlog of orders due to inadequate production capacity. Delivery delays are running eighteen months for a 323i and six to eight months for other 3-series models. High investments are also committed for diesel development with Steyr-Daimler-Puch. A 1982 introduction date is projected. BMW is aiming its diesel program primarily at the U.S. market to meet CAFE regulations and secondarily at other export markets where diesel fuel is priced well below gasoline. Since diesel fuel and gasoline prices are on a par in Germany, diesels may not be offered by BMW for the home market.

To increase production, BMW will invest $120 million at the Dingolfing auto plant in Germany over the next two and one-half years. The number of employees will rise from 36,000 to approximately 38,000.

BMW and Steyr-Daimler-Puch will jointly build a new plant in Vienna for the 1982 diesel production, employing between 1,000 and 2,000. The joint program plans an annual rate of 100,000 units. Steyr has had prior production experience in the diesel field with volumes of 30,000 units per year. Since Steyr has no car production and BMW will not require the full output, a percentage of the diesel production will be available to other manufacturers who do not own diesel manufacturing facilities. Construction of the Vienna plant is scheduled to begin before the end of 1979 with volume produc-

TABLE 3-3. BMW MANUFACTURING PLANTS

	Plant	Product	No. Employees	No. Units Produced 1977	1978 Production Rate
DOMESTIC VEHICLE MANUFACTURING PLANTS	Munich	3 Series	19,360 (2)	167,500 (approximately) (1)(3)	1400/day (5)
	Dingolfing	5, 6, 7 Series	11,613	118,750 (approximately) (4)	
DOMESTIC PASSENGER CAR COMPONENT PLANTS	Munich	Engines for all models	Included above	Data not Available	Data not Available
	Dingolfing	Press shop, Spare parts warehouse	Included above		
	Landshut	Plastic parts for 7 Series from plant & deep drawing machine for sheeting			
FOREIGN VEHICLE MANUFACTURING PLANTS	Pretoria, S. Africa	7 Series (6) 5 Series	Over 1,000	3,960 (approximately) (7)	50/day (8)
	TOTAL			290,236 (9)	

TABLE 3-3. BMW MANUFACTURING PLANTS (Concluded)

NOTES:

① This compares with approximately 220,000 units of complete 6 cylinder series for total period between 1968 and February 1977 (including 2500, 2800, 2.8L, 3.0Si, 3.0L, 3.3Li).

② Includes head office and component production.

③ Total 1977 series 3 production: 670 units/day average x 250 days/yr. = 167,500 units/yr.
Calculated based on production rate of 620 units/day at beginning of 1977 and 700 units/day at end of 1977 (Annual Report 1977, p. 8).

④ Total 1977 production at Dingolfing plant: 475 units/day (average) x 250 days/yr. = 118,750 units/yr.
Calculated based on production rate of 430 units/day at beginning of 1977 and 570 units/day at end of 1977, of which 150/day were 7 series (introduced in 1977). (Annual Report 1977, p.8).

⑤ Fall 1978 production at Munich and Dingolfing plants increased to 1400 units/day (both plants combined) to catch up with backlog (Auto News 10/30/78, p. 39).

⑥ South African plant also produces motorcycles and components, and has training facilities.

⑦ Total 1977 car production in S. Africa estimated: 330 cars/month (average) x 12 month/yr. = 3960 cars/yr.
Calculated based on production rate of:
450 units/month of cars and motorcycles at beginning of 1977 (estimate 280 cars/month)
800 units/month of cars and motorcycles at end of 1977 (estimate 500 cars/month)
(Annual Report 1977).

⑧ In 1978, S. African car production doubled to 50 cars/day, with further expansion planned. S. Africa already exports 150 BMW 518 models to Iran each month. (Ward's Auto Report, 10/23/78, p. 241).

⑨ Annual Report 1977, p. 61.

tion scheduled for 1981/1982. Cost of the project is estimated at $150 million.

3.4. Current Product Line and Sales

Table 3-4 displays BMW's current product lines by sales and vehicle configuration. The first digit of the model code designates the body styling (or series); the second two digits represent engine size (i.e., 33 = 3.3 liter engine); and the "i" indicates fuel injection. The latest sales figures through August 1978 indicate BMW sales of 20,847 units up 9.3 percent from the same eight month period last year when 19,067 units were recorded.

TABLE 3-4

BMW: U.S. CURRENT PRODUCT LINE 1977

Model	Engine/Transmission	Price	U.S. Sales 1977	% U.S. Market 1977 (Approx.)
320i	L-4, FI, 4M/3A	$10,000	19,519	67.8
530i	L-6, FI, 4M/3A	15,000	7,239	25.16
633Csi	L-6, FI, 4M/3A	23,800	Introduced 1978	Introduced 1978
733i	L-6, FI, 4M/3A	21,365	Introduced 1978	Introduced 1978

Note:
2002, 3.0 Si, 630csi, all discontinued, accounted for remaining 7.04% of sales.

Key:
L-4 = 4 cylinder engine
L-6 = 6 cylinder engine
FI = Fuel injection
4M = 4 speed manual
3A = 3 speed automatic

Source:
Wards Auto World 4/78 p. 28.
Wards Automotive Yearbook 1977 p. 43, 46, 53.

320i

Introduced to the U.S. in 1977 as a replacement for the 2002, the 320i sedan, on a 100.9" wheelbase, has a 112 hp, four cylinder fuel injected engine with a choice of four speed manual or automatic transmission. The 320i, retailing in the range of $10,000, is the least expensive U.S. model, and was intended to set a pattern for BMW of offering slightly larger and more expensive packages while retaining a performance image, separating BMW from the other higher priced German automobiles such as Mercedes-Benz. 1977 sales of 19,519 accounted for 67.8 percent of BMW's total U.S. market. In comparison, 1976 sales figures of 1,763 represented only 6.7 percent of BMW's total U.S. Market. The latest sales figures through June 1978 of 10,707 were up 3 percent from the same six month period in 1977 when 10,399 units were recorded.

530i

Introduced to the U.S. in 1975, the 530i, on a 103.8" wheelbase, is a six cylinder, fuel injected sedan with a choice of four speed manual or automatic transmission. The 530i, retailing in the range of $15,000, had 1977 sales of 7,239, representing 25.2 percent of BMW's U.S. Market. In comparison, 1976 sales figures of 6,606 represented 25.4 percent of BMW's U.S. Market. The latest sales figures through June 1978 of 3,229 were up 0.9 percent from the same six month period in June 1977 when 3,201 units were recorded.

633 Csi

Introduced to the U.S. in mid-1978 as a replacement for the 630 Csi, the 633 Csi, on a 103.4" wheelbase, is a limited production sports coupe with a six cylinder, fuel injected engine and optional ZF automatic transmission. The 633 Csi, retailing in the range of $23,800, is the most expensive of the model line, geared to the buyer wanting a combination of both performance and the Mercedes type of luxury. Sales figures through June 1978 indicate that 150 units had been sold in 1978.

733i

Introduced to the U.S. in mid-1978 to replace the 3.0 Si sedan, the 733i is the most recent BMW passenger car import to the U.S. The 733i sedan, on a 110.2 wheelbase, has a six cylinder, 177 hp fuel injected system with optional ZF automatic transmission. The introduction of the double-pivot front suspension system is being marketed as the "ultimate driving machine" combining a sport car's handling ability with a luxury sedan's comfort. Sales are projected at 1,600 for the end of the 1978 calendar year. The 733i retails at $21,365, midway between the higher priced 633 Csi and 530i. 1978 sales data is not available.

3.5 Future Technology

Company research projects currently concentrate on improving fuel economy.

A new small BMW 6 cylinder engine was introduced in 1977. In both dimensions and weight, it falls between BMW's 4 cylinder and large 6 cylinder engines but, because it is particularly short for an in-line 6 cylinder with its cubic capacity, (2.0 and 2.3 liters), it can be used in the 3-series vehicles. The engine block is made of cast iron and the cylinder head of light alloy.

Projecting to 1985 and beyond when U.S. CAFE requirements are 27.5 miles per gallon, BMW hopes AVL's research will produce direct injection four-stroke diesel engines suitable for passenger car use. AVL (Anstart Fuer Verbrenningsmotoren, translated as Institute for Internal Combustion) has sold engine designs to such manufacturers as Alfa Romeo and Ford of Germany. AVL is working to perfect the four-stroke diesel direct injection engine to achieve higher effeciency and better fuel economy. The engine was previously rejected for passenger car use due to roughness and high noise levels which AVL successfully reduced.

BMW recognizes the importance of weight reduction for improved fuel economy and plans a modest weight reduction program which will concentrate on component changes and material substitution rather than downsizing vehicles. Although specific changes have not been announced, several models were reduced about 200 pounds in 1978 including the 5-series sedan which lost about 180 pounds.

In addition to the diesel engine planned with Steyr-Daimler-Puch AG, BMW is developing another diesel engine which would be a converted small in-line six cylinder gasoline engine using the same block but a modified cylinder head. It would have a compression ratio of 23:1 and a displacement of 2.4 liters (compared to 2.0 and 2.3 liter gasoline engines).

BMW is also researching a 3 x 6 gasoline engine (dual displacement) for possible future production (mid-1980's at the earliest). Electronic fuel injection is planned, as well as recirculation of exhaust gas to the deactivated cylinders to keep them warm, prevent excessive wear, make the transition to combustion smoother, and lower emissions. Methods of extracting exhaust gas energy for improved fuel economy are also under investigation.

3.6 Vehicle Product Plans

BMW's major concern for its U.S. export market is meeting the CAFE requirements. The BMW passenger cars in 1978 averaged 19.7 mpg, complying with both the 1978 and 1979 CAFE standard. However, significant improvement in fleet fuel economy is needed for BMW to satisfy the 1985 27.5 mpg requirement.

BMW is currently developing a turbocharged version of its in-line six cylinder engine in Munich. If production is approved, the turbocharged engine could be offered in the 600-series coupes and 700-series sedans in the early 1980's.

As previously mentioned, the company will produce its first diesel car in the 1980's, in cooperation with Steyr-Daimler-Puch.

BMW is currently testing a coupe version of the 3-series (prototype called 420) powered by a small six cylinder engine. Vehicle configuration will be hatchback or fastback or combination. Although the hatchback version of the BMW 2002 was discontinued in 1977 due to poor sales performance, BMW feels that there is now a market for a smaller coupe.

In addition, BMW will replace the current 530i model (3.0 liter engine) with the 528i model (2.8 liter engine) in 1979. The 528i has a three-way catalyst with a Lambda sensor emission control system for greater fuel economy.

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BMW

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Wards Automotive Reports	10/23/78	p. 241.
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Boston Globe	6/11/78	p. 6.
Road & Track	5/78	p. 104.
Wards Auto World	4/78	p. 28.
Wards Automotive Reports	9/11/78	p. 290
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	9/26/78	Insert
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Wards Automotive Yearbook 1978		p. 43.

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BMW

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	8/28/78	p. 16.
	10/16/78	p. 1.
	11/6/78	p. 104.
Road & Track	2/78	p. 54.
Wards Auto World	6/78	p. 50.
Wards Engine Update	4/14/78	p. 2.

4. VOLVO

4.1 Introduction

Volvo, the larger of the two Swedish passenger car producers (the other being Saab), faced financial problems during 1977 as corporate profits fell to 2.9% of sales, production volume dropped 23%, and a 2% devaluation of the Swedish currency caused a domestic sales loss of 15% (in Skr/million (m)). However, results for the first six months of 1978 indicate an increase of 21 percent in sales and 67 percent in net earnings. Volvo is in a situation, unlike other auto manufacturers, in that its domestic market is shrinking and only accounted for 23 percent of sales in the first half of 1978. Volvo markets two series of vehilcles: 240/260 series worldwide, and 343/66 series in the Netherlands.

Volvo is actively seeking new capital sources to finance research of new products and increase market penetration of current products. Following a financial loan and purchase of additional shares in Volvo Car BV by the Dutch government, and purchase of forty percent of Volvo shares by Norway in 1978, Volvo's capitalization will be the equivalent of $352 million. Future plans for the company include research into turbocharged engines, further development of the diesel engine, and production of lightweight aluminum and plastic components to reduce vehicle weights.

Volvo intends to remain competitive in the U.S. market. Introduction of the six cylinder diesel passenger car is planned for 1979 in Europe and 1980 for the U.S. U.S. sales in 1977 increased 6.6 percent for a total of 46,790 units while the Volvo total corporate passenger car sales declined 8 percent to 261,000 units in 1977. U.S. sales figures through August 1978 of 33,829 are up 9.2 percent from the same eight month period in 1977 when 31,076 units were recorded.

4.2 Corporate Financial Profile

Volvo's total passenger car sales decreased 7.8 percent to 261,000 units in 1977 from 283,000 units in 1976, and decreased

15% in value from Skr 8,441 m in 1976 to Skr 8,310 m (equivalent of $3.5 billion) in 1977. Sales outside Sweden rose 5 percent to Skr 6,075 m in 1977 compared with Skr 5,801 in 1976. Production was limited to a volume lower than sales in 1977 to reduce a carry-over inventory from 1976. 171,200 units were produced in 1977, a 23 percent decrease from 222,500 in 1976.

Volvo's investment rate has decreased from 10 percent of turnover in the 1971-73 period to 5 percent in 1976. The company is planning similar low investment rates for 1978 since they have adequate plant capacity and invest mainly in product development where costs are not reported as investments.

In the U.S., sales have increased 6.6 percent from 43,887 in 1976 to 46,790 in 1977. The low volume in 1977, in comparison with a 1975 level of 60,338 units, was caused by several factors, including a dock strike in the United States which interrupted shipments, and Volvo's difficulty in establishing a position in the luxury market with an image of being a supplier of high quality but lower priced cars.

The U.S. market is the second largest market for Volvo with almost 19% of all Volvo sales. In 1977, Volvo held 2.3 percent of the U.S. import market (ranking ninth), and 0.4 percent of the total U.S. market (ranking thirteenth). Total U.S. sales for 1977 were in the range of $350 million. Volvo of America projects 1978 sales equal to 1977 sales. However, the most recent sales figures for the first eight months of 1978 of 33,928 show that Volvo sales have increased 9.2 percent over the same period in 1977.

Tables 4-1 and 4-2 present Volvo financial information for 1977.

In mid-1977, Volvo announced that it was undertaking a major capital reconstruction program in Norway, whereby forty percent of Volvo shares will be offered to Norwegian investors in return for $162 million in capital from the Norwegian government. This followed unsuccessful negotiations with Saab-Scania to merge in 1977 and a request denied by the Swedish government for $214 million to develop

TABLE 4-1. VOLVO CONSOLIDATED BALANCE SHEET

	(Skr m.) Dec. 31, 1977	Dec. 31, 1976
Assets		
Current Assets	12,439.7	11,188.1
Blocked Accounts in Bank of Sweden	115.2	93.2
Fixed Assets	4,435.1	4,423.7
Total Assets	16,990.0	15,705.0
Liabilities and Shareholder's Equity		
Current Liabilities	7,174.0	6,897.8
Long-term Liabilities	3,661.2	2,922.7
Untaxed Reserves	4,018.4	3,984.1
Minority Interest in Capital	185.3	65.4
Total Shareholders' Equity	1,951.1	1,835.0
	16,990.0	15,705.0
Assets Pledged	2,833.2	2,361.2
Contingent Liabilities*	854.5	531.0
Investments Approved	955.7	1,051.2

* Includes conditional liability of 193 for repayment of contribution made to Volvo Car BV by the Dutch government.

TABLE 4-2. VOLVO CONSOLIDATED INCOME STATEMENT (Skr m.)

	1977	1976
Sales	16,167.8	15,742.9
Cost of Operations*	14,934.5	14,430.3
Operating Income before Depreciation	1,233.3	1,312.6
Depreciation	599.4	558.0
Financial Income and Expenses	169.0	171.3
Extraordinary Income and Expenses	113.6	1.4
Income Before Allocations and Taxes	351.3	581.9
Allocations	34.2	422.7
Income Before Taxes	317.1	159.2
Minority Interest in Income	+ 11.2	+ 15.7
Taxes	130.1	111.9
Net Income	198.2	63.0

* Expenses were reduced 193, through receipt of contribution from Dutch Government to Volvo Car BV.

a new model. Two holding companies will be formed: Norwegian Volvo will own forty percent of the present Volvo company and Swedish Volvo AB will control the other sixty percent. The Norwegian funds will be used to establish an oil company (Volvo Petroleum AB) to drill the Norwegian Continental Shelf and to establish an auto parts plant in Norway to produce aluminum and plastic components.

The other capital announcement in 1977 was the purchase of over $35 million of shares (or an additional twenty percent) in Volvo Car BV (formerly DAF) by the Dutch Government. In addition, the Dutch state company DSM will lend Volvo AB $48.5 million for the 1978-1980 operating period, to be repaid when Volvo Car BV earns a profit. Volvo AB will match the Dutch contribution with $39 million. DSM has promised Volvo AB an additional $59 million by the end of 1980 and, if Volvo Car BV breaks even by 1982, DSM and Volvo will return to the respective 25/75% shareholder ratio which was in effect prior to 1977. Volvo Car BV's total capitalization is now $130.1 million.

Similar to the move by BL Ltd., Volvo plans a corporate restructuring to be completed by 1978. In this plan, the Truck Division, Bus Division, and Volvo BM (tractors, forestry machines and public works equipment) will be grouped into one unit, Volvo Commercial Vehicles, for more efficient use of facilities and more effective marketing. The Car Division will continue the three-part set-up initiated in early 1978 of Marketing, Production and Volvo Car BV (formerly DAF). Volvo cars will stay in their current market segments; however, Volvo plans to broaden the model base and changes will be more frequent.

4.3 Manufacturing Facilities

Volvo operates nine passenger car production facilities worldwide, as shown in Table 4-3.

Total car production declined 24% from 296,800 units in 1976 to 225,700 in 1977. The two Swedish plants at Gothenburg and Kalmar

TABLE 4-3. VOLVO PRODUCTION FACILITIES

VEHICLE SERIES	PLANT	1977 PRODUCTION	EMPLOYEES	CAPACITY	BREAK-EVEN	COMMENTS
240/260	Gothenberg (Sweden)	107,200 (1)	15,870 (7)	178,700 (4)		Supplies components for foreign assembly plants. Production rate = 15 units/hr (2) (vs. 40-60/hr in U.S.)
240/260	Kalmar (Sweden)	17,900 (1)	535 (7)	30,000 (9)		
240/260	Ghent (Belgium)	33,400 (1)	3,450 (7)			
240/260	Indonesia	5,900 (1)				
	Malaysia		326 (7)			
	Thailand		135 (7)			
	Australia		589 (7)			
240/260	Halifax (Canada	6,800 (1)	309 (7)			
240/260	TOTAL	171,200		250,000-300,000 (2)	about 200,000 (2)	
66	Born (Netherlands)	22,500-25,000 (2)				
343	Born (Netherlands)	32,000-35,000 (2)				
66/343	TOTAL	54,500 (1)		160,000 (2)	100 - 120,000 (2)	
ALL	TOTAL	225,700 (1)				
1600cc Engine for 343	Dourrin (France)		3,490 (7)			Jointly operated by Volvo, Renault, Peugeot
Engines	Skovde (Sweden)	300,000 (8)				Gasoline and diesel engines for passenger and commercial vehicles (including B-21 4-cyl. gasoline engines.)

1 Annual Report 1977, p. 11.
2 Auto News 9/23/78, p. 14.
3 Wall Street Journal 3/1/77.
4 Plants in Sweden ran at average 60% capacity.
5 AN 2/13/78, p. 32.
6 AR 1977, p. 5.
7 AR 1977, p. 41.
8 Pehr Gyllenhammar, People at Work, 1977.
9 Company literature.

produce the majority (55%) of Volvo's passenger cars. Gothenburg produced 107,200 cars in 1977, a 23 percent decrease from 138,000 produced in 1976; Kalmar produced 17,900 cars in 1977, a 19 percent decrease from 22,100 in 1976. Overall, 70 percent of Volvo's plants are located in Sweden.

Components such as bodies, engines, gearboxes, axles and interior fittings are mainly manufactured at plants in Gothenburg and Belgium for the 240/260 Series, and in the Netherlands for the 343 and 66. Other components are supplied by about 1500 sub-contractors all over the world.

Volvo has designed several programs and plants which focus on job enrichment for the workers. It has selectively replaced the traditional assembly line with assembly of vehicles by groups and has automated many production functions. The Kalmar plant, opened in early 1974, serves as the model with production divided into body assembly, chassis assembly and final assembly. A central computer routes specially-designed vehicle carriers throughout the plant; each vehicle and group of workers is, therefore, independent of others. Welding operations at Gothenburg and machining operations at Skovde are automated.

Currently, Volvo has no active production facilities in the U.S. In 1974, Volvo acquired a 514 acre site in Chesapeake, Virginia, and began construction of an assembly plant comprised of service installations and an assembly hall. After Volvo's sales in the U.S. declined from 60,338 in 1975 to 43,887 in 1976, and the Dutch affiliate DSM suffered heavy losses, assembly plans were cancelled. To date, the facility is only used for new car preparation of complete vehicles built in Sweden. Gyllenhammer, President of Volvo stated that when the sales volume in the U.S. justifies production, assembly plans will continue. If production plans do go forward, Volvo of America predicts 2,000 employees and an annual capacity of 200,000, although it would be economical to produce as few as 60,000 vehicles; the prime function would be final vehicle assembly using European supplied components. Considering Volvo of Sweden currently operates at seventy percent capacity, it is unlikely that the U.S. plant will start production in the near future.

The Volvo Canada Ltd. manufacturing plant in Halifax supplies a small portion of vehicles to the U.S. Overall production at that plant has declined steadily in recent years (from 13,337 units in 1975 to 9,487 in 1976 to 6,826 in 1977) due to introduction of a shorter work week and curtailment of production in order to reduce the inventory of finished units to a normal level.

Volvo also participates in joint programs with other auto and supplier companies. Among them VW will supply Volvo with 6 cylinder diesel engines designed jointly by VW and Volvo. The new 262C model was designed by Volvo but was built in Italy by Bertone. As indicated in Table 4-3, Volvo, Renault, and Peugeot jointly operate an engine plant in France which includes production of Volvo's 1.6 liter engine used in the 343 model.

4.4 Current Product Line

Table 4-4 provides a breakdown of current product lines and sales. The first digit of the model number indicates the series; the second digit specifies engine type (4 or 6 cylinder); the third digit refers to the number of doors (2 = 2 door; 4 = 4 door sedan, 5 = station wagon), C = Coupe, DL = Deluxe, GL = Grand Luxe, and GT = Grand Touring.

The latest sales figures for Volvo of 33,928 through August 1978 indicate that sales are up 9.2 percent from the same eight month period last year when 31,076 units were recorded.

242 Sedan (2 door)

Equipped with a four-cylinder fuel injected engine and a choice of four speed manual, electrically operated overdrive and automatic transmission, the 242 sedan retailing at $6,645 had sales of 9,888 in 1977, representing 21.1 percent of the United States Volvo market. In comparison, 1976 sales figures of 8,469 represented 19.3 percent of total U.S. Volvo sales. 1978 sales totalled 8,263 through September 1978.

242 GT

Introduced to the United States in 1978, the 242 GT is aimed at the sports sedan market currently dominated by BMW. The 242 GT is a modified version of the 2.1 liter 242 series with improved suspension, a four-speed manual transmission with overdrive and four-cylinder engine. One piece of standard equipment common to both the 262C and the 242 GT is the Lambda-Sond Oxygen Sensor and three-way catalyst emission controls. Retailing at $15,000, the 242 GT is the most expensive model in the Volvo range and places Volvo in the price range of BMW, Audi and the lowest priced Mercedes, as well as the more luxurious U.S. cars. Volvo of America is only planning to import a few thousand GTs a year, since eighty percent of sales are in the 240-series sedans and station wagons. 1978 sales totalled 2,164 through September 1978.

244 Sedan (4 door)

Equipped with a four-cylinder, fuel injected engine and a choice of four speed manual, electrically operated overdrive and automatic transmission, the 244 sedan retailing at $7,145 had sales of 11,268 in 1977, representing 24.1 percent of the United States Volvo market. The 1976 sales figures of 9,575, in comparison, represented 21.8 percent of total U.S. Volvo sales. In 1978, the only modification to the 244 was new front end treatment taken from the 1977 264 model. 1978 sales (through September) totalled 10,424 units.

245 Wagon

Equipped with a four-cylinder, fuel injected engine and a choice of four speed manual, electrically operated overdrive and automatic transmission, the 245 retailing at $7,750 had sales of 11,866 in 1977, representing 25.4 percent of the Volvo U.S. market. In comparison, 1976 sales figures of 9,962 represented 22.7 percent of total U.S. Volvo sales. 1978 sales (through September) totalled 8,735 units.

262 C Coupe

Introduced to the U.S. in 1978, the 262 C is aimed at the luxury GT coupe market represented by Mercedes' 280 CE and 300 CD. The 262 C has a fuel-injected 2.7 liter, V-6 engine, with a choice of four-speed overdrive or automatic transmission. Retailing at $14,700, the 262 C is one of the more expensive Volvo models. Volvo is planning to import only 1200 262 C's to the United States in 1978, following the pattern set by the 242 GT of a limited production model. 1978 sales (through September) totalled 586 units.

264 GL Sedan (4 door)

Equipped with a fuel injected V-6 engine, and a choice of four speed overdrive or automatic transmission, the 264 GL, retailing at $10,850 had sales of 9,428 in 1977, representing 20.1 percent of the Volvo U.S. market. A comparison with the 1976 sales figures of 12,848 shows 29.3 percent of total Volvo sales. 1978 sales (through September) totalled 6,900 units.

265 Wagon

Equipped with a fuel injected V-6 engine and a choice of four speed overdrive or automatic transmission, the 265 retailing at $10,495, had sales of 3,541 in 1977, representing 7.6 percent of the Volvo U.S. market. In comparison, 1976 sales figures of 2,515 represented 5.7 percent of total Volvo sales. 1978 sales (through September) totalled 1,816 units.

TABLE 4-4

VOLVO: U.S. CURRENT PRODUCT LINE 1977

Model	Engine/Transmission	Price	U.S. Sales 1977	% U.S. Market 1977 (Approx.)
242 Sedan	L-4, FI, 4M/4OD/3A	$ 6,645	9,888	21.13
242 GT Sedan	L-4, FI, M4/4OD	15,000	Introduced 1978	Introduced 1978
244 Sedan	L-4, FI, 4M/4OD/3A	7,145	11,268	24.08
245 Wagon	L-4, FI, 4M/4OD/3A	7,750	11,866	25.36
262C Coupe	V-6, FI, 4OD/3A	14,700	Introduced 1978	Introduced 1978
264GL Sedan	V-6, FI, 4OD/3A	10,850	9,428	20.15
265 Wagon	V-6, FI, 4OD/3A	10,495	3,541	7.57
TD				1.71

Key:
V-6 = V-6 engine.
L-4 = 4 cylinder engine
FI = Fuel injection
4M = 4 speed manual
4OD = 4 speed overdrive
3A/4A = 3/4 speed automatic
TD = Tourist delivery.

Source:
Motor Trend 3/78, pp 66, 67.
Road & Track 3/78 p. 51
Wards Automotive Yearbook 1977 p. 47, p. 41, 53.

4.5 Future Technology

Company research projects currently focus on improving fuel economy, since all United States export cars will have to meet the 27.5 mpg CAFE requirement in 1985.

Volvo is developing a turbocharged engine for passenger vehicles; of note is the fact that the U.S. Transportation Department Safety Vehicle is powered by a Volvo B-21 turbocharged engine. In a computer study, Volvo compared a turbocharged diesel with a gasoline truck engine and claims up to eighty percent fuel economy improvement for the diesel.

A Materials and Components development unit to be located by Volvo in Norway will supply aluminum and plastic parts for the new, weight-reduced models for the 1980's.

It is reported that Volvo may develop a two-seat, lightweight minicar for the United States market.

4.6 Vehicle Product Plans

Following the development of the diesel engine by such manufacturers as Mercedes and Volkswagen, Volvo plans to market a 6-cylinder diesel passenger car in Europe in early 1979 in both a GL and GLE version; U.S. diesel introduction is expected at the beginning of 1980. Models 264 D6, 262 D6, and 265 D6 will be powered by a 2.4 liter in-line six-cylinder diesel engine built by VW in Germany. This joint engine development program between Volvo and VW was initiated in 1976.

According to the president of Volvo of America, only so much weight could be removed from the present line of cars. The European version of the 343, produced by the Dutch DAF affiliate, is the smallest Volvo model with a 1.4 liter, four-cylinder engine and manual transmission. However, Volvo probably will not introduce the 343 model into the U.S. to meet federal fuel economy regulations. Marketing problems in the U.S. are associated with the small engine size which limits the car's performance to 70 mph, its image as a small family sedan at a very high price, and the need for improved emissions controls to meet future U.S. standards. In addition, approximately 500 pounds of apparatus would need to be added to the European model to meet U.S. safety standards, thereby, minimizing any fuel economy benefits over the 240/260 series.* Volvo may offer a four speed manual transaxle and is also testing alternative powerplants such as the six cylinder engine used in the Renault 14.

To further enhance its image as a safe, reliable car, Volvo plans to use air bag restraints on all cars in 1983. However, Volvo believes that the Volvo-type safety belt provides as much protection as the air bag and blames the seat belt designs of U.S. manufacturers for the recent additional safety regulations.

Volvo also has option rights to buy a 2-liter five cylinder diesel from VW (used in the Audi 5000), but no deal has been concluded.

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*Automotive News October 23, 1978, p. 45.

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VOLVO

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5. BL LTD (Formerly British Leyland)

5.1 Introduction

Through 1977, BL Ltd. was the largest producer of passenger cars in the United Kingdom, ahead of Chrysler U.K., Ford U.K., and General Motors U.K. Of the four producers, BL is the only non-U.S. multi-national and is 95 percent state-owned.

During the 1977 fiscal year, the company experienced financial difficulties as corporate earnings plunged 118 percent, total production of passenger cars decreased 5.4 percent, and car sales (in British pounds) decreased 40.4 percent from 1976. A major reorganizational plan, introduced in 1978, represents a final effort to remain a major automobile producer. The plan calls for a 7 to 10 percent reduction in the workforce, a reconstructuring of the firm's manufacturing operations, a request for additional government funding and purchase of newer, more sophisticated manufacturing equipment.

As part of the company's restructuring, the present operating unit will be divided into three units: BL Cars, Ltd.; Leyland Vehicles; and SP Industries. BL Cars will have three car-making subsidiaries: Austim-Morris will produce and sell high volume cars; Jaguar, Rover and Triumph will handle medium ranges; and BL Components will handle parts, foundry and body operations. Leyland Vehicles, Ltd. will produce commercial vehicles and the third unit, SP Industries, Ltd. will handle military vehicles and construction equipment. This decentralization puts the BL Ltd. parent company in the position of a holding company and establishes separate marketing, manufacturing and heavy duty divisions which might survive independently if the automobile operations fold.

5.2 Corporate Financial Profile

BL's total passenger car sales in 1977 were 785,000, a decrease of 5.4 percent from 981,000 units in 1976, although monthly sales were somewhat comparable.[1] Production, affected by company strikes, fell 5.4% from almost 690,000 units in 1974 to 651,000 units in 1977 and resulted in a 1977 U.K. market share of 24.3% compared to the 27.4 percent share in 1976. 1977 export shipments of 334,000 units took 45 percent of the total output, a decrease of 27,000 units from 1976. Total sales in the BL Car group were £1,723 million in 1977 ($4.95 billion), a decrease of 40.4 percent compared with £ 2,892 million for the previous 15 month period. Sales for the first half of 1978 have risen 18.1 percent to $3.06 billion from $2.59 billion in the comparable 1977 period.

In 1977, the company lost $99 million, $84 million of which was attributed to plant closings and other non-recurring charges. The Leyland Car Division losses of $57.4 million in 1977 (largely due to the Speke plant losses of $40 million) almost neutralized the $63 million profits earned by the Special Products Division (15.1 million) and the Commercial Vehicle Division ($47.9 million).

The British government, who owns 95% of the company, approved a short-term load of approximately $500 million in the spring of 1978, but expects to increase this to $850 million in 1978. A total of $1.62 billion of capital may be needed by 1981. At that time the government expects British Leyland to show a 10 percent return on capital. The latest BL financial report showed a 74 percent rise in 1978 first half net income, from $9 million in the first half of 1977 to $15.6 million in 1978.

Table 5-1 presents the BL financial summary for 1975-1977.

British Leyland Motor Inc., a subsidiary, has been the U.S. distributor since 1968, The company currently concentrates on the sports and luxury car market, having dropped out of the economy sedan market in 1975. Sales of sports cars increased 13 percent in

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[1] In 1976, BL's accounting year was changed to end December 31 instead of September 30 as in prior years. Therefore, for 1976 statements only, the accounting period included 15 months (Oct. 1, 1975 - Dec. 31, 1976).

TABLE 5-1. SUMMARY OF RESULTS 1975 - 1977

Consolidated	1975 £ million	1976* £ million	1977 £ million
Sales			
UK	919	1,316	1,320
Overseas	949	1,576	1,282
	1,868	2,892	2,602
Exports from UK (included above)	589	1,048	854
Profit before interest and taxation	(38.1)	117.7	56.7
Interest payable less interest receivable	(38.0)	(47.2)	(53.6)
Profit before taxation	(76.1)	70.5	3.1
Taxation	12.9	(24.0)	(8.1)
Profit after taxation	(63.2)	46.5	(5.0)
Minority interests in subsidiaries	(0.7)	(2.3)	(3.0)
Earnings (before extraordinary items)	(63.9)	44.2	(8.0)
Extraordinary items	(59.6)	—	(43.9)
Dividends	—	—	—
Transfer to (from) reserves	(123.5)	44.2	(51.9)
Assets			
Fixed assets	257.4	310.9	383.3
Special tools, dies and jigs	47.5	34.9	28.0
Trade investments	10.9	15.4	13.6
Net current assets	(63.6)	151.7	197.6
	252.2	512.9	622.5
Financed by			
Capital and reserves			
Ordinary share capital	29.6	129.6	129.6
Reserves	108.5	249.9	198.0
	138.1	379.5	327.6
Convertible unsecured loan stock	26.7	26.7	26.7
Loans from National Enterprise Board	—	10.0	160.0
Other loan capital and long term loans	77.9	80.7	80.7
Minority interests in subsidiaries	6.4	8.8	21.6
Corporation tax	—	—	—
Deferred liabilities	3.1	7.2	5.9
	252.2	512.9	622.5
Capital expenditure including tooling (before grants)	92.4	114.2	148.8
Vehicle sales in units	845,000	981,000	785,000
Weekly average number of employees	191,000	183,000	195,000
Ordinary shareholders (period end)	108,000	101,000	96,000
Loan stockholders of BLMC (period end)	88,000	82,000	76,000

Figures in brackets denote losses and deductions from profits or earnings.

The figures for 1976 and 1977 reflect the change in the accounting policy for deferred taxation
* The figures for 1976 are for the 15 months ended 31 December.

Source: BL Annual Report 1977, p. 37, 38.

1977. 1978 sales, however, are expected to be lower due to a supplier strike at, and subsequent relocation of, the TR-7 assembly plant resulting in a reduction of U.S. exports (75% of the TR-7 output). Overall U.S. sales have increased 5.1 percent from 65,164 units in 1976 to 68,476 units in 1977. BL projects 1978 sales below the 1977 figures, due again to supply shortages. The latest sales figures for BL of 36,356 through August 1978 indicate that sales are down 28 percent from the same 8-month period last year when 50,529 sales were recorded.

The U.S., one of BL's largest export markets, represented 8 percent of total BL sales with 1977 sales valued at $204 million. BL ranks sixth with 3.3 percent of the U.S. imports and ranks tenth with 0.6 percent of the total U.S. market.

BL's first half net income in 1978 increased 74 percent. A succession of 346 disputes in six months between late 1977 and early 1978 has made continuous production an impossibility and unless labor problems are eliminated, BL's first half financial improvement is unlikely to be maintained.

Actions to dispose of distribution subsidiaries in Norway and Sweden are well advanced.

5.3 Manufacturing Facilities

BL has embarked on a major reorganization plan which calls for additional government funding, a 7 percent reduction in a workforce of 180,000, a restructuring of manufacturing operations and a $1.5 billion program to modernize existing plants and develop new models.

A production goal of 819,000 cars per year, compared with a capacity of 1 million, was announced in early spring 1978 by the chairman of BL. Production of the Range Rover and Land Rover is expected to double over the next six years to an annual capacity of 125,000 Land Rovers and 29,000 Range Rovers through an expansion program costing BL $440 million.

The introduction of a new Mini model for 1980 requires major retooling at the Longridge plant where the model will be assembled.

Several stamping plants will be modernized for an investment of $100 million, bringing the costs for development of the new Mini to $450 million.

Labor problems and low productivity rates hamper BL's production efforts. An internal report revealed that BL plants produce only 45 to 55 percent of the 40 hour week compared to 67 to 75 percent at other European plants (West German VW plants, French Renault plants and French Chrysler plants).

BL Cars Limited operates ten vehicle assembly plants in England and one in Belgium, as described in Table 5-2. BL International Limited is responsible for overseas assembly plants, outlined in Table 5-3. In addition, several foreign distributors own plants producing BL cars.

The Speke plant, which assembled the TR-7 model until summer of 1978, has had the lowest productivity of all BL plants. A lengthy suppliers strike at the plant in fall of 1977 halted production until February 1978. Production resumed again until May 1978 when the operations were transferred to a new plant at Canley where production began October, 1978. Consequently, introduction of the new TR-8 V-8 model has been postponed until mid-1979.

BL Cars Limited, through its recently reorganized BL Components Limited unit, also operates twenty-eight component plants in eleven areas in England. Employment statistics and product descriptions are contained in Table 5-4. Seven of these component plants were organized into one marketing structure, <u>SU Butec</u> in August 1976: SU Fuel Systems; Beans Engineering; Oxford Exhaust Systems; Llianelli Radiators; Rearsby Components; Butec Electric; and Alford and Alder. The Group is one of the leading British component organizations and supplies Leyland and other leading auto manufacturers (including Rolls Royce, Chrysler, Renault, Volvo, Ford and Reliant). SU Butec is investing $26 million for production of aluminum radiators, silencers and exhaust systems for BL cars in the 1980's.

BL recently completed talks with Renault and is now engaged in talks with VW on common development and use of components, presumably to negotiate a three-way link-up to match the economy of scale inherent in the Peugeot-Citroen-Chrysler link-up.

TABLE 5-2. BRITISH LEYLAND DOMESTIC VEHICLE MANUFACTURING PLANTS (1)

AREA	PLANT	PRODUCT/MODEL	EMPLOYEES (1976)
Birmingham	Longbridge	Mini, Allegro; also gearbox for Mini, Allegro, Marina, Maxi and Princess	24,000
	Common Lane	Sherpa	2,050
	Solihull	Rover 3500, Land Rover, Range Rover	9,200
Coventry Area	Canley	Dolomite, Spitfire; also engine, gearbox for Dolomite, Spitfire, TR7 and MG Midget. TR7 production added October 1978. (2)	9,500
	Allesley	Jaguar, Daimler	5,000
Liverpool	Speke	TR7 (discontinued in mid 1978); (3) body for Dolomite	3,000 (3)
Oxford Area	Cowley	Marina, Maxi, Princess	8,600
	Abingdon	MGB, MG Midget	1,100
London Area	Vanden Plas Kingsbury	Daimler Limousine	350

(1) British Leyland Facts & Figures, Autumn 1977.

(2) Ward's Auto Report 5/22/78 p. 16; Auto News 3/13/78 p. 63.

(3) Wall Street Journal 2/16/78 p. 19. 3,000 jobs cut from previous 6,000 at Speke plant with removal of TR7 production.

TABLE 5-3.

BRITISH LEYLAND MAJOR OVERSEAS VEHICLE MANUFACTURING PLANTS - PASSENGER CARS

COUNTRY	CITY	PRODUCTS	EMPLOYEES (1976)	BL OWNERSHIP
Australia	Sydney	Mini range, Land Rover (also tractors and bus)	1,009	100%
Belgium	Seneffe	Mini, Allegro (Built from 75% UK manufactured components)	2,500	100%
(1) South Africa	Blackheath	Mini, Marina, Jaguar, Engines	1,943	97.5%
Zambia	Ndola	Land Rover, Range Rover	169	75%
Kenya	Thika	Land Rover, Range Rover, Commercial vehicles	250	45%
New Zealand	Nelson	Land Rover, Triumph, Jaguar, Princess	395	13.3%
	Petone	Maxi, Honda Civic	307	
	Panmure	Mini range, Allegro, Commercial vehicles	380	
	New Market	Mini range, Marina		
Portugal	Setubal-Lisbon	Mini range, Marina, Allegro, Leyland LCV, Land Rover	673	
Nigeria	Ibadan	Commercial vehicles, Land Rover, Range Rover	under construction	47.1%
Phillipines	Valenzuela	Land Rover, Commercial vehicles	40	40%
(2) Spain	Linares	Land Rover	2,407	27.3%
Zaire	Kinshasa	Land Rover, Range Rover, Commercial vehicles	128	79%

Distributor owned plants for cars and Land Rovers:
Angola; Costa Rica; Ethiopia; Ghana; Indonesia; Iran; Italy; Malaysia; Malagasy; Malta; Morocco; Mozambique; Nigeria; Singapore, Tanzania; Thailand; Trinidad; Venezuela

(1) Closed car assembly operations in 1977

(2) Liquidation of Spanish company during 1977 nearly complete.

TABLE 5-4. BRITISH LEYLAND DOMESTIC COMPONENT MANUFACTURING PLANTS

AREA (In Britain)	PLANT	PRODUCT	EMPLOYEES (1976)
Birmingham	Castle Bromwich	Body manufacture Rover 3500, Jaguar range, Mini pressings, subassemblies, trim and tooling	7,800
	Drews Lane	Suspension and Steering parts	3,800
	*SU Fuel Systems	Carburetors and Fuel Pumps	1,200
	Acocks Green	Engines and Gearboxes for Rover Saloons, Range Rover, and Land Rover	1,200
	Tyseley 1 & 2	Engines for Land Rover, Gearboxes for Range Rover	1,660
	Tyburn Road	Gearbox Cases, Bell Housings, etc.	350
	Percy Road	Land Rover Gearboxes	500
	Perry Barr	Axles	450
	Garrison Street	Land Rover Chassis Frames and Trim	760
	Bordesley Green	Spitfire Bodies, Range Rover Body Assemblies, Petrol Tanks, Engine Sub-frames	830
	Beans Foundries	Iron Castings	1,300
	*Beans Engineering	General Automotive Components and Engine Reconditioning	1,000
	Kings Norton	Soft Trim for Mini and Allegro	270
Coventry	Radford (Jaguar)	Jaguar Engines, Rear Axles, Suspension and Gearboxes	2,800
	Coventry Engines	Industrial and Marine Engines, Diesel Engines Reconditioning Austin Morris Engines	3,500

TABLE 5-4. BRITISH LEYLAND DOMESTIC COMPONENT MANUFACTURING PLANTS (CONCLUDED)

AREA (In Britain)	PLANT	PRODUCT	EMPLOYEES (1976)
Oxford	Cowley Body	Body manufacture Marina, Maxi, Princess and Rolls Royce, Paint and Trim MG Bodies. Knockdown for exports, Tooling.	10,200
	*Oxford Exhaust Systems	Silencers, Exhausts, Air Temperature Control Units and other components.	1,100
Swindon	Swindon Body	Body manufacture MG, Rover 3500 Pressings and Assemblies. Allegro, Marina, Maxi, Princess Pressings. Tooling.	5,400
South Wales	Pengam & St. Mellons	Gearboxes, Axles, Suspensions	1,100
	Llanelli Pressings	Body Pressings and Plastics	1,800
	*Llanelli Radiators	Radiators, Heater Units, Silencers, etc.	2,400
	Bargoed	Fabrications	200
Leeds	West Yorkshire Foundries	Aluminum and Iron Engine and Transmission Casings	1,600
Leicester	*Rearsby Components	Fabricated Assemblies and Small Components	730
Northants	Wellingborough Foundries	Cylinder Block and Head Casings	650
Leyland	*Butec Electric	Alternators, Starter Motors, etc.	400
Dunstable	Dunstable Tool & Die	Tool and Die Manufacture	280
Hemel Hempstead	*Alford & Alder	Rack and Pinion Steering, Brake Drum, Axle Assemblies	1,100

SOURCE: British Leyland Facts and Figures, Autumn 1977.

*These seven component manufacturing plants were organized into one marketing structure, SU/BUTEC in August 1976. The Group is one of the leading British component organizations and supplies Leyland and other leading manufacturers including Rolls Royce, Chrysler, Renault, Volvo, Ford, Reliant.

5.4 Current Product Line and Sales

Tables 5-5 and 5-6 concisely describe BL's current product lines and sales.

Jaguar XJ6

Introduced to the United States in 1968 and equipped with a 6-cylinder electronic fuel injected engine with 3-speed automatic transmission, the XJ6 four-door sedan retails at $18,375. The electronic fuel injection system was first introduced in 1978 in place of twin carbs and is similar to the system used on the XJ-12 and XJS models. 1977 total U.S. Jaguar sales (models XJ6, XJ-12 and XJS) of 4,349 accounted for 6.4 percent of BL's total U.S. market. In comparison, 1976 sales figures for the total Jaguar line of 7,382 represented 11.3 percent of total U.S. BL sales. The latest sales figures for Jaguar through October 1978 indicate that sales were up 3.1 percent to 3,916 units from the same 10-month period in 1977 when sales of 3,800 were recorded.

Jaguar XJ-12

Introduced to the United States in 1974, equipped with a 5.3 liter V-12 electronic fuel injected engine and 3-speed automatic transmission, the XJ-12 four-door sedan retails at $17,750. The automatic transmission option, introduced in 1978 is a modified version of GM's hydramatic 400 and provides smoother gear changes, a more responsive downshift and a more rapid reaction to the manual selector.

Jaguar XJS

Equipped with a 5.3 liter V-12 electronic fuel injected engine and 3-speed automatic transmission, the XJS 2-door coupe retails at $22,750. In conjunction with the XJ-12 model, a modified version of the GM turbo hydramatic 400 transmission was introduced on the 1978 model.

MG Midget

Equipped with a 4-cylinder engine, a one-barrel carburetor and a 4-speed manual transmission, the MG Midget 2-door convertible retails at $4,495, making it the "lowest price true sports car" in the United States. The MG line consists of two small sports convertibles, the Midget and the MGB and is the top selling BL line in the United States. 1977 total MG sales (models Midget and MGB) in the U.S. of 34,794 accounted for 50.8 percent of BL's total U.S. line. In comparison, 1976 sales figures of 28,426 represented 43.6 percent of total BL sales. The latest sales figures for MG of 24,374 through October 1978 indicate that sales were down 23.7 percent from the same 10 month period in 1977 when sales of 31,940 were recorded.

MG MGB

Equipped with a 4-cylinder engine a one-barrel carburetor and a 4-speed manual transmission, the MGB 2-door convertible retails at $5,649.

Triumph Spitfire 1500

Equipped with a 4-cylinder engine, a one-barrel carburetor and a choice of four-speed manual or overdrive transmission, the Spitfire 2-door convertible retails at $4,895. The Triumph line, like the MG line, consists of two high-performance sports cars. The Spitfire's strongest selling point in 1978 will be its convertible top, since there are only 8 soft-top convertibles in the United States market. 1977 U.S. total Triumph Sales (models Spitfire and TR-7) of 29,258 accounted for 42.8 percent of BL's total U.S. line. In comparison, 1976 sales figures of 28,238 represented 43.3 percent of total BL sales. MG and Triumph held equal U.S. market shares in 1976 but MG surged ahead to a 50.8% market share in 1977. The latest sales figures for Triumph of 14,961 through October 1978 indicate that sales were down 43.4 percent from the same 10 month period last year when sales of 26,448 were recorded.

Triumph TR7

Equipped with a 4-cylinder engine, 2 x 1 barrel carburetor and a choice of 5-speed manual or 3-speed automatic tranmission, the TR7 2-door coupe/convertible retails at $6,349. For the 1978 model, an optional hardtop and coupe style were offered. Seventy-five percent of total TR7 output is exported to the United States. In 1977 TR7 sales of 18,000 in the U.S. accounted for 26.3% of BL's total U.S. sales and 61.5% of the Triumph line (models Spitfire and TR7) sales of 29,258. 1978 sales are currently 31% behind the 1977 rate due to an interruption in production for approximately 9 months caused by a strike, and subsequent relocation, of the Triumph assembly plant. Consequently, introduction of the new TR8 V-8 model has been postponed until mid-1979.

5.5 Future Technology

BL is developing a diesel engine based on the D-Series gasoline engine as an option for the 1980 Princess model with front-wheel drive, and transverse installation. This model is not expected to be offered in the U.S. product line.

Reportedly, the company seeks aid from the Nissan Motor Company of Japan for a joint program including development of new models and export engines. BL is said to be interested in purchasing both diesel engines and four-cylinder gasoline engines from Nissan.

No additional research and development projects at BL covering fuel economy, emissions control, weight reduction or alternative fuels have been reported.

TABLE 5-5. BL LTD.: U.S. CURRENT PRODUCT LINE

Model	Engine/Transmission	Price	U.S. Sales October 1978 Year-to-Date	U.S. Sales October 1977 Year-to-Date	Total 1977 U.S. Sales
Jaguar XJ6L Sedan	L-6, FI, 3A	$18,375			
Jaguar XJ12L Sedan	V-12, FI, 3A	17,750	3,916	3,789	4,349
Jaguar XJS Coupe 2+2 GT	V-12, FI, 3A	22,750			
MG Midget Convertible	L-4, 1bbl, 4M	4,495	24,374	31,916	37,784
MG MGB Convertible	L-4, 1bbl, 4M	5,649			
Triumph Spitfire Convertible	L-4, 1bbl, 4M	4,895	14,961	26,408	11,258
Triumph TR7 Coupe	L-4, 2x1bbl, 5M/3A	6,349			18,000
Austin					75
TOTAL			43,251	62,113	68,401

Source:

Automotive News 4/24/78 p. 4; 5/22/78, p. 3.
Boston Globe 6/11/77 p. 9.
Motor Trend 2/78 p. 48; 6/78, p. 71.
Wards Auto World 7/78 p. 9; 6/78, p. 51.
Wards Automotive Reports 3/2/78, p. 100; 11/6/78, p. 357.
Wards Automotive Year Book 1977, pp. 46, 53.
Wards Engine Update 10/28/77, p. 3.

Key:

L-4 = 4 Cylinder Engine
L-6 = 6 Cylinder Engine
V-12 = V-12 Engine
FI = Fuel Injection
1bbl = 1 Barrel Carburetor
2x1bbl = 2 Barrel Carburetor
4M/5M = 4/5 Speed Manual
3A = 3 Speed Automatic

TABLE 5-6. BRITISH LEYLAND MODEL LINE AND PRODUCTION

MODEL	NO. CAR VERSIONS	ENGINES (cc)	1976 (1) JANUARY-DECEMBER PRODUCTION BUILDUP	1976 KNOCKED DOWN (FOR ASSEMBLY OVERSEAS)
Mini	5	848; 998; 1098; 1275	109,444 (Longbridge) 43,229 (Seneffe)	37,729
Allegro	10	1100; 1300; 1500; 1750	75,834 (Longbridge) 24,736 (Seneffe)	5,088
Marina	12	1300; 1800; 1800 twin carb	105,400	7,326
Triumph Dolomite	4	1300; 1500; 1850; 1998	36,105	
Maxi	1	1500; 1750; 1750HL	33,386	1,632
Triumph Spitfire	1	1493	18,914	
Triumph TR7	1	1998	31,744	
MG	3	1493; 1798	29,741 (MGB) 16,878 (Midget)	
Princess	4	1800 (4 cyl), 2200 (6 cyl)	45,304	72
Jaguar/Daimler	4J; 4D	3442; 4235; 5343	20,263 (Saloon)	924
Rover 3500	1	3528	3,291 (XJ-S) 8,649 (SD1) 7,718 (P6/P6B)	
Land Rover	1	2250 (gas); 2250 (diesel); 2600 (gas)	33,988	14,554
Range Rover	1	3500	8,475	1,080
Sherpa Van			13,864	3,990
(b) Triumph 2000/2500			11,451	5,760
TR6			6,083	
(a) Triumph Stag			3,109	
Taxi			2,531	
			692,137	78,155

(a) Discontinued in 1977 along with Jaguar XJ Coupe

(b) Replaced by Rover 2300 and 2600 versions in 1977. Not to be sold in U.S.

(1) British Leyland Facts & Figures, Autumn 1977.

5.6 Vehicle Product Plans

BL will invest $440 million over the next 6 years to double production of its four-wheel drive Land Rover and Range Rover, providing an annual capacity of 29,000 Range Rovers and 125,000 Land Rovers. Currently BL holds 15% of the world's four-wheel drive market of 500,000 units, whose annual growth rate is 5%. This expansion program is vital for BL to retain and increase its world market share, particularly since Mercedes-Benz plans to build a four-wheel drive vehicle within the next 18 months. Besides increased production, model improvements are also planned. Sales increases in the United States are projected after the V-8 engine meets federal emission standards.

BL also plans a new small car, longer and wider than the present British Mini. The program's costs are projected at between $450 million and $500 million and BL has already begun to place tooling orders for the model, due in 1980. In addition, a new medium-sized car is planned to be built at the Cowley plant.

For the United States market, BL expects to introduce the Rover 3500 with a 3.5 liter V-8 engine for the 1980 model year if the emissions and fuel economy standards are met. To date, the model has not yet cleared emission testing.

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	10/9/78	p. 1.
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6. COMPONENT MANUFACTURERS

6.1 Introduction

Although vehicle manufacturers generally design, produce, and assemble major vehicle components in-house, many parts and component systems are purchased from outside suppliers (independent component manufacturers and/or other auto makers) at a lower cost than could be produced internally.

The role and structure of the independent component supplier industry in Europe has changed dramatically over the past decade as European auto suppliers and manufacturers have increasingly integrated their activities in response to the growing perception of Europe as a single market. As vehicle manufacturers sell and sometimes assemble vehicles in foreign countries, they seek component sources on an international scale for price advantages, to maintain an uninterrupted supply of parts through alternative sourcing, and to establish rapport with the host country by investing capital and creating new jobs. Independent component suppliers from the OEM home country want to follow the auto makers across borders while suppliers in the host country vie for a share of new business.

Suppliers also recognize the advantage of customer variety and less dependency on a single vehicle manufacturer. The larger component groups in particular (listed in Table 6-1) are increasing their multinational investments and most of them have become substantial exporters.

The recent emphasis on technology, particularly to meet U.S. fuel economy and emission standards, and the capital resources required for such development programs, present additional challenges to the European suppliers and auto makers. Auto manufacturers encourage independent supplier existence with whom they sometimes engage in joint R&D and manufacturing efforts.
Some of the suppliers and auto makers look to the U.S. firms for technology, contrary to general impressions held here. For instance, BMW's 1977 U.S. purchases included engine block heaters, gaskets,

chrome trim rings, air conditioners, stereos and citizen band radios, spark plugs and electrical components, batteries and tires. BMW is considering additional parts and plastic components, as well as engine and transmission components and certain luxury items such as central locking, power antennas, and electric window lifts. BL and BMW have ordered SPS Technologies, Inc.'s automated bolt-tightening equipment. VW will use Kelsey-Hayes' disc brake calipers on its U.S. produced Rabbits.

6.2 Market Opportunities

Competition for markets has increased between European and U.S. supplier firms. Although a few U.S. firms (such as Carborundum and Timkin) established European subsidiaries before World War II, many other U.S. component manufacturers did not actively pursue the European market until the 1960's and 1970's. Table 6-2 lists U.S. firms with significant European subsidiaries. With the advent of the U.S. downsizing program, American firms with European ties have an advantage of capitalizing on the small car technology developments from the European market.

But there are also increased opportunities for European component manufacturers in the United States. Many are experts in small diesel engines and fuel injection equipment, and have more experience in the design and manufacture of front-wheel-drive, and smaller dimensional components such as brakes. For instance, Bosch, Lucas, and GKN have recently established or are in the process of setting up U.S. manufacturing facilities. It is expected that other companies will actively pursue the U.S. market over the next decade, thereby strengthening bilateral exchange of capital and technology.

Much of the integration among European suppliers has come by take-overs, mergers, and cross shareholding. Independent component manufacturers generally support extensive mergers and expansions; the increased production efficiencies gained are needed to compete in an international setting, particularly against U.S. component makers and subsidiaries of the OEM's. Also, many independent suppliers promote strong pan-European groups in an effort to encourage more coordinated trade with the European Economic Community (EEC, or Common Market) block, and to break down some of the national monopolistic practices (groups which control at least 70% of the local market in specific product areas).

However, certain product areas in Europe are already cornered by only two or three major producers such as:

Electrical parts - Bosch (Germany) and Lucas (UK)

Universal-Joint technology for front-wheel-drive cars - Hardy Spicer, the GKN subsidiary (most of balance assumed by Peugeot-Citroen vehicle manufacturing group)

Precision engine parts - Associated Engineering (UK) and Mahle (Germany)

Instrumentation - Smiths (UK), VDO (Germany), Jaeger (France - which is 45% owned by VDO)

Clutch manufacturing - Automotive Products (UK), Sachs (Germany) and Ferodo (France)

Automatic Transmissions - Borg-Warner (U.S.)

Spark Plug - Champion (U.S.), Bosch. (GM and Ford have very large-scale in-house production)

Taper roller - bearings - Timkin (U.S.)

6.3 Government Influence

The attitudes and actions of various European governments greatly influence the proliferation of mergers. Because monopolistic attitudes vary between countries and over time, suppliers must accommodate diverse policies simultaneously. France's primary interest in restructuring its component industry is to strengthen its local manufacturing base, hoping to create a powerful French component group which could compete internationally. Italy is dominated by Fiat's interests, whereas Britain has maintained a fairly neutral position. In West Germany, the Government Cartel office is most concerned with maintaining a high degree of competition, which many companies interpret to mean that no mergers are permitted which would enable a company to dominate a field.

6.4 West Germany

German OEM vehicle manufacturers are reputed to be more vertically integrated than counterparts in other countries; as a consequence, a smaller percentage of the finished auto product is obtained from outside suppliers. However, volume growth has generated more opportunities for those few who are already established suppliers. Except for the acquisitive entry of some major U.S. firms, the structure of the German component industry has been generally stable; even this recent activity may end if the German Cartel office believes it to be anti-competitive. Because of the current popularity of the German cars, there is still opportunity for component makers to serve the spare parts aftermarket which so far has not been strongly pursued by the OEM suppliers. However, with the declining growth rate expected for the European car industry against the background of increased price competition from Japanese, third world, and U.S. manufacturers, this situation could change as well.

Of the German component manufacturers listed in Table 6-3, the largest is Robert Bosch, with about 60% of its sales generated in motor components. Bosch has been particularly aggressive toward overseas manufacturing operations in support of German assembly plants, as in Brazil and the Far East. It has a large U.S. subsidiary generating sales of $120 million, a strong position in fuel injection equipment through licenses in the Japanese market, and has substantial investments in other firms (including 9.3% share of Borg-Warner, a leading U.S. transmission firm). Among its customers, Bosch equips Mercedes-Benz with gasoline and diesel Continuous Injection Systems (CIS). Bosch and Mercedes-Benz corroborated on an anti-skid brake system; since it is safety-related, Daimler-Benz policy permits free use of the design by other companies and BMW will probably offer a similar system, called ABS.

Mercedes-Benz also developed automatic transmissions for commercial vehicles jointly with IVECO and supplies automatic transmissions for the Porsche 928.

Sometimes a third party controls both an auto maker and component supplier, such as the Quandt family, who controls BMW while owning 60% of the stock of Varta, a West German holding company and producer of the best-selling German battery. Varta has battery manufacturing facilities in Brazil, Argentina, Colombia, and Mexico, and in turn acquired a 60% majority holding in an Ohio battery firm among its foreign investments.

Among the other suppliers, Bendix closed its German plants three years ago but still supplies brakes for Mercedes-Benz from its factory in France. VDO's (Vereinigte Deuta OTA) electronic monitoring system was adapted for the BMW 630/633 coupe (for monitoring brakes, fluid level, window washer level, radiator coolant level, engine oil level, brake light functioning, tail light functioning, and brake pad wear). BMW purchased automatic transmissions from Zahnradfabrik Friedrichshafen (ZF). Mahle developed oil cooled pistons for diesel engines which are used in the turbocharged Mercedes-Benz 5-cylinder diesel engine. Girling, a subsidiary of the British firm Lucas, supplies brakes to Volvo, VW, Opel, Ford, Renault, Peugeot, and British Leyland cars. BMW, and other manufacturers, purchase turbochargers from Kuehnle, Kopp and Kausch of Germany. Mercedes-Benz, on the other hand, purchases its turbochargers from Garrett AiResearch in California.

6.5 France

The major French component manufacturers and electrical component sectors are displayed in Tables 6-4 and 6-5. Jaeger, France's leading maker of automotive instruments, is the main supplier to the domestic industry and also supplies Mercedes-Benz, Fiat, Alfa Romeo, Ford, VW, and Rolls Royce. The major item of interest among French component manufacturers is over control of Ducellier, which is now jointly owned by Bendix of the United States and Lucas of England. Lucas bid for the remainder of the equity, which by any normal standard should have been noncontroversial since Bendix and Lucas were bound by the terms of their partnership in Ducellier to sell only to each other. However, SEV (Societie d'Equipment des Vehicles), France's largest leading component group, is also bidding for Ducellier. If SEV succeeds, this would create a single dominant group in France. Although it has caused some concern among auto makers (now Renault and Peugeot/Citroen/Chrysler) the merger might appeal to the French government's desire for a French component group of sufficient size to be capable of competing internationally.

6.6 Italy

Fiat dominates the Italian auto and component manufacturers with 43 domestic and three overseas plants; more than 31,000 employees; and sales of about $1340 million. It is as highly integrated as British Leyland, Citroen and Ford. In the past ten years, however, a fair number of multinational manufacturers (see Table 6-6) have moved into Italy to compete with Fiat. In fact, the Fiat Components Group competes heavily with outside suppliers for business from its own vehicle manufacturing group. The Fiat component group exported about 25% of its sales in 1977 and hopes for a total of about 30% for 1978. It is also looking for an affiliation with another producer to tackle the important but expensive field of vehicle electronics.

6.7 Britain

In Britain, many smaller component manufacturers have been totally dependent on British Leyland and cannot invest in overseas markets. Mergers or takeovers by larger firms are expected if British Leyland business declines further and the proportion of imported vehicles with imported components continues to increase.

Consolidation and expansion to multinationalism for the larger British component manufacturers (Table 6-7) occurred in the 1960's, prior to the recent trend in the rest of Europe. Now, however, these companies are experiencing greater competition in the home market from foreign firms and seek to establish themselves as a major supplier to the vehicle manufacturers on a world-wide basis.

6.8 Conclusion

The trend for major component suppliers to invest internationally and broaden markets for original and replacement parts is expected to continue, particularly as auto makers increase their scope of activity. Furthermore, as the cost and effort required to meet U.S. fuel economy, emissions, and safety standards increases while the time remaining diminishes, independent suppliers must share the cost with the auto makers in developing new technology and production facilities.

TABLE 6-1.

LEADING EUROPEAN COMPONENT COMPANIES INCLUDING TIRE AND BATTERY CONCERNS*

	Country	Sales ($)	After-tax Profits ($)	Employees	Activities
Dunlop-Pirelli	UK-Italy	4.2bn	na	164,000	Tires
Michelin	France	3.4bn	$157m	110,000	Tires
Robert Bosch	Germany	3.3bn	86m	110,000	Electrics/ electronics
GKN	UK	2.7bn	55m	108,000	Pressings; forgings; transmission parts
Lucas Industries	UK	1.4bn	55m	79,000	Electrics/ electronics
Varta	Germany	838m	19m	22,000	Batteries
Continental Gummi-Werke	Germany	741m	4.7m	24,000	Tires
ZF	Germany	645m	7.7m	17,000	Automatic transmissions
Ferodo Groupe	France	552m	23m	20,000	Clutches; brake linings
Associated Engineering	UK	480m	21m	29,000	Pistons; piston rings; bearings
DBA	France	468m	2.7m	18,000	Brakes; electrics
Chloride Group	UK	457m	22m	21,000	Batteries
Sachs	Germany	454m	19m	16,000	Clutches; shock absorbers

*This list does not include American-controlled component companies in Europe. 1976 data.

Source: Financial Times 6/6/78
(from Fortune--500 largest industrial corporations outside the U.S., August, 1977)

TABLE 6-2. MAJOR U.S. COMPONENT MANUFACTURERS IN EUROPE

Company	Products	Location
TRW	Valves	UK (TRW Valves); Germany (Teves-Thompson); France (Jeudy)
	Steering gears	UK (Cam.); Germany (Ehrenreich); France (Gemmer); Italy (TRW-Italia)
	Steering wheels, fasteners	UK (Clifford)
	Seat belts	Germany (Repa)
ITT	Brakes	Germany (Teves); UK (Teves); France (Teves)
	Electric switchgear	Germany (SWF)
	Gaskets/lights	Italy (IAO)
	Shock Absorbers	Holland (Konl)
Bendix	Brakes/electrical equipment	France (DBA--jointly owned with Lucas); Spain (Bendiberica)
	Air brakes	UK (jointly owned with Westinghouse Brake and Signal)
	Brake linings	Germany (Jurid)
Eaton	Truck transmissions	UK; France
	Axles	UK; Spain
	Valves	Spain; Italy
Dana	Transmissions	UK
	Piston rings	France (Floquet Monopel);
	Distribution	UK (Brown Brothers)
Rockwell	Axles and axle housings	UK (Rubery Owen Rockwell--jointly owned with Rubery Owen; Rockwell Thompson; Rockwell-Standard)
	Window regulators	Germany (Golde); Italy (Golde Italiana)
	Automotive seating	Portugal (Mollgal)
Champion	Spark plugs	UK; Belgium
Timken	Taper bearings	UK; France; Germany
American Standard	Air Brakes	Germany (Webco); UK (Clayton Dewandre)
Carborundum	Friction materials	UK
	Diesel engine parts	UK (Weyburn Engineering)
Borg Warner	Automatic transmissions	UK
Tenneco Walker	Exhausts	UK; Germany; France
	Distribution	UK; Germany; Belgium (Pit Stop)
Monroe	Shock absorbers	Belgium
Trico	Wipers	UK
ITW	Fasteners	UK
Dayco	Fan belts	UK
Questor	Shock absorbers	Spain

Source; Financial Times 6/6/78

TABLE 6-3. MAJOR COMPONENT MANUFACTURERS IN GERMANY

COMPANY	PRODUCT	PARENT/OWNERSHIP
Robert Bosch	Vehicle electrics, spark plugs, fuel injection equipment	--
Varta	Batteries	--
VDO	Instruments	--
Kronprinz	Wheels	Mannesmann
Karl Schmidt	Pistons, thin wall bearings, steering wheels	Metallgesellschaft
Mahle	Pistons	--
Goetze	Piston rings	--
Nural	Pistons	Alcan (Canada)
Wyzeman	Cylinder liners	--
Alfred Teves	Brakes, piston rings, valves	ITT (U.S.)
Glyco	Thin wall bearings	--
FAG	Rolling bearings	--
SKF	Rolling bearings	SKF (Sweden)
St. Gobain	Safety glass	St. Gobain Pont & Mousson (France)
Reinz	Gaskets	--
Elring	Gaskets	--
TRW	Valves	TRW (U.S.)
SWF	Vehicle electrics	ITT (U.S.)
ZF	Transmissions	Zeppelin Group
Voith	Transmissions	--
Uni-Cardan	Transmissions	GKN (UK)
Fichtel and Sachs	Clutches, shock absorbers	GKN (UK) - 25%
Textar	Brake linings	BBA (UK)
Jurid	Brake linings	Bendix (U.S.)
Girling Bremsen	Brakes	Joseph Lucas (UK)
Behr	Radiators	--
KLR	Radiators	--
Boge	Shock Absorbers	--
Renk	Transmissions	GHH
WABCO-Standard	Truck brakes	American Standard (U.S.)
Champion Zundkerzen	Spark Plugs	Champion (U.S.)
Conti-Gummiwerke	Tires	--
Phoenix Gummiwerke	Tires	--
Michelin Relfen-werke	Tires	Michelin (France)
Draftex	Door seals	Laird Group (UK)
Dunlop	Tires	Dunlop (UK)

Source; Financial Times 6/6/78

TABLE 6-4. MAJOR COMPONENT MANUFACTURERS IN FRANCE

COMPANY	COUNTRY	PRODUCT
Ferodo	France (Turner and Newall of UK has 10%)	Clutches (Verto trade name); aluminum radiators (Sofica); brake linings
SEV-Marchal/ Paris-Rhone-Ciblé	France (70% Ferodo, 30% Bosch)	Vehicle electrics; lights
DEA	U.S./UK	Vehicle electrics; brakes
	Aciers et Outillage	Bumpers; chains; steering wheels
France	(Peugeot has 70%)	
Lucas	UK	Diesel equipment (Roto-Diesel); brakes (Freins Girling).
Associated Engineering	UK	Pistons
GKN	UK	Universal joints (Glenser-Spicer)
Wilmot Breeden	UK	Door latches; plastics
Automotive Prods.	UK	Clutch remanufacturing
Eaton	U.S.	Commercial vehicle gearboxes
ITT	U.S.	Brakes (Teves)
Dana	U.S.	Piston rings (Floquet Monopol)
Jaeger	France (45% VDO of Germany)	Instruments
Solex	France	Carburetors
St. Gobain	France	Cylinder liners
Bosch	Germany	Fuel injection equipment (Sigma Diesel); electrical products (Robert Bosch)

Source: Financial Times 6/6/78

TABLE 6-5. THE FRENCH ELECTRICAL COMPONENTS SECTOR

Company	Parent Company	Turnover 1976 Frs.m.	Workforce	Main Products
SEV	Ferodo/Bosch	2,200*	15,500	Projectors, alternators, starters, small motors
Lucas-France	Lucas Industries	1,191 (a)	7,500	Injection equipment, braking systems, diesel equipment (b)
Ducellier	Lucas/DBA	801	7,000	car electronics
DBA	Bendix	1,357* (c)	10,600	brakes and air equipment
Jaegar	VDO-Schindling	625	5,000	dashboards, infloometers, commutators
Precision Mechanique	Labrinal	544 (d)	5,390	electrical and cable harness equipment
Seima		390	4,000	signalling equipment
Motorola		53	460	alternators
Bosch-France	Bosch	250	Products imported	alternators

*1977 figures: (a) participation pro rata. (b) aerospace electronics via Thomson-Lucas. (c) Ducellier. (d) Frs. 307m in motor industry.

Source: Financial Times 6/6/78

TABLE 6-6.

MAJOR COMPONENT MANUFACTURERS IN ITALY

COMPANY	COUNTRY	PRODUCT
Fiat	Italian	1. Comind group: Plastic and rubber components: lighting equipment; electrical cables; electrical equipment. 2. Gilardini group: Hoses; gaskets; filters; pumps; transmission gears; body parts. 3. Magneti Merilli: Batteries; plugs; ignition systems; wipers generators; horns. 4. Weber, carburetors; brakes.
ITT	U.S.	IAO Group: Bumpers; plastics; gaskets; tail lights; servo systems; shock absorbers; exhausts.
Ferodo	France	Brakes; headlights; clutches; radiators.
Associated Engineering	UK	Pistons; piston rings; bearings.
Eaton	U.S.	Valves.
TRW	U.S.	Steering gears; piston rings.
Lucas	UK	Carello (40% stake): Headlights; wipers.
Trioni	Italy	Plain bearings.
Turner and Newell	UK	Gaskets.
Revlmec	Italy	Brakes (Automotive Products has 28%).

TABLE 6-7.

MAJOR BRITISH COMPONENT MANUFACTURERS

COMPANY	PRODUCT
Dunlop	Tires
GKN	Pressings; forgings; transmission parts;
Lucas Industries	Electrics/electronics
Associated Engineering	Pistons; piston rings; bearings
Chloride group	Batteries
Turner and Newall	Gaskets
Automotive Products	Clutch manufacturing
Wilmot Breeden	Door latches; plastics

Source: Financial Times 6/6/78

6.9 References

Financial Times (London)	6/6/78	p. 19 - 25.
	6/22/77	p. 17 - 22.
Automotive News	9/12/77	p. 1, 18, 45, 46, 47.

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Ward's Auto World	9/78	p. 35.

7. PROJECTED CURB WEIGHTS

7.1 Introduction

Because of the likelihood that some import manufacturers (Mercedes-Benz, BMW, Volvo, BL) may have difficulty in meeting future fuel economy standards, an analysis was performed to determine the extent to which weight could be removed, by manufacturer and model, for the 1983 and 1986 timeframe.

This section details the procedure and subsequent results, which involved four task areas:

1. Establish 1978 baseline weights for each model;
2. Assess vehicle weight reduction methodologies such as: vehicle redesign; component weight changes; and engine changes;
3. Formulate specific weight reduction strategies to be employed by each manufacturer; and
4. Project curb weights by model. Arrange vehicle weight data by EPA Market Class and determine arithmetic average weights of sedans for each market class and manufacturer.

Few specific plans have been announced by the import manufacturers regarding their vehicle weight reduction programs. As a consequence, indirect methods had to be applied. In view of worldwide market objectives and the nature of the product, these manufacturers are more apt to lean toward cost effective techniques implemented in proportion to the U.S. market's percentage of worldwide sales. Higher weight classes benefit most from weight reduction efforts. Due to the lack of definitive plans, this analysis elected to focus on the American experience in reducing weight of component subassemblies via material substitution and parts redesign, selecting those components which offer the import manufacturers to most benefit. Since weight has such a large payoff in terms of fuel economy benefits to be gained, detailed examination of import manufacturers' weight reduction efforts was performed under the assumption that import manufacturers avail themselves of the U.S. manufacturer weight reduction experiences, but with consideration given to the extent of implementation feasible by the import manufacturers. Because of the speculative nature of the subject, the results should be viewed more qualitatively than quantitatively particularly with regard to projections beyond 1981. Also, since these manufacturers' vehicles do not necessarily compete head-to-head in the marketplace, the results of each manufacturer's effort should be viewed independently in conjunction with individual plans.

7.2 Establishment of 1978 Baseline Curb Weights

The 1978 baseline provided a logical reference point for developing a rational projection of future vehicle weights.

Baseline curb weights were derived primarily from the 1978 MVMA Specifications. Occasionally, when such data was not available, engineering and trade journals were used as alternative sources. Except for Volvo, most import manufacturers offer only a single version of each vehicle; that is, no optional engines; only one model configuration (coupe, sedan, wagon); as well as one set of features. Any variations between vehicles because of engine size or type (diesel and/or turbocharged) or configuration constitute separate model classification, with new model codes or names. Frequently, the only available choice is the selection between automatic or manual transmissions and often even this is not provided.

Consequently, these European manufacturers (except Volvo) are prone to include as standard equipment, many features considered optional by U.S. manufacturers--if those features are available at all. This equipment includes air conditioning, choice of transmission, power steering and brakes, power windows and seats, inside lights, radio, clock, trim packages.

Volvo classifies models by engine size, vehicle configuration, and trim package but does offer certain options at extra cost within each model line.

Tables A-1, A-2, A-3, and A-4 list the baseline curb weights for Mercedes-Benz, BMW, BL, and Volvo, respectively. In addition to model name and base curb weight (in pounds), selected specifications for each model are provided: wheelbase, engine/transmission, 1978 combined EPA miles per gallon and EPA market classification, and weights of options for Volvo. For comparative purposes, the EPA mileage ratings for comparable U.S. cars (of similar weight) are included; the weights represent "loaded" U.S. models which include all available options since, as discussed above, most imports include such features in the basic car.

7.3 Weight Reduction Methodologies

Similar weight reduction techniques are available to the manufacturers although the pattern and magnitude of implementation vary according to a manufacturer's individual circumstances and resources for a given model year. The principal weight loss categories identified are:

A. Complete redesign and introduction of all new vehicles;

B. Major sheet metal changes; and

C. Component and assembly redesign, and material substitution (token losses).

A fourth category, implicit in each of the above, are weight losses attributed to smaller engine/drivelines.

These methods are not mutually exclusive in that a manufacturer may employ any combination of techniques for a model (or model lines) in order to achieve weight reduction goals at a minimum cost. Weight reduction programs are keyed to a manufacturer's product plans for new vehicle introductions, styling changes and, in part, to technological improvements in power plants, transmissions and material usage.

7.3.1 New Vehicle Introductions

Since foreign manufacturers generally offer only a portion of their entire fleet to the U.S. market, it is relatively easy for them to change the mix with other models already offered in the home market. As a general practice, most new models are introduced in Europe at least one year prior to U.S. entry, although some models are specifically designed for the U.S. market, i.e., Mercedes' 300 SD and BMW's 530i.

Development cycles and scheduled production runs are historically longer for European models than for U.S. models. A six-year model development cycle is generally used by Mercedes-Benz with production runs of eight years; the designed vehicle life span is twelve years compared to only ten years for U.S. vehicles. Volvo's current U.S. line, introduced in 1975, replaced the 100 series which ran for eight years in the U.S. Although all of BMW's current U.S. models are new since 1975, its 733i model took seven years to develop and BMW started planning its replacement prior to actual introduction. British Leyland has sold its Mini model in Europe for eighteen years; a new Mini scheduled for production at the end of 1979 may be offered in Europe while the old Mini is still being produced. Other British Leyland models in the U.S. today have been selling since the 1960's with only minor modifications. However, these cycles may be shortened such that models now in development would be introduced sooner because of the possible redesign for weight reduction beyond 1981.

All models must also comply with U.S. emission and safety standards, and sometimes the additional cost and weight needed to federalize the European version outweigh potential fuel economy benefits to be gained. For these reasons, Volvo so far has decided against exporting its 343 model to the U.S.; needed safety improvements to the European version would add about 500 pounds, thereby mitigating fuel economy benefits and possibly competing against other Volvo model sales.

7.3.2 <u>Complete Vehicle Redesign</u>

Substantial weight loss can be achieved by totally redesigning a vehicle. This may involve alterations in wheelbase size, body dimensions, and/or conversion to front-wheel-drive. In addition, indirect weight savings attainable through the use of lighter support systems can be realized.

Rediminsioning often involves a downsizing of the wheelbase and shortening the length, width, and height of the vehicle. The geometric relationships between the major frame reference points, or "hard points", are altered; that is, the distances between the front windshield support, the center beam behind the front door, the beam behind the rear seat, and the rear roofline support, (A, B, C, and D pillars respectively) are modified. (In a 2 door model, the C and D pillars are often combined). A manufacturer could "adjust" the wheelbase up or down to coincide with one used on another model, usually to reduce manufacturing costs associated with new model introductions. In most cases, manufacturers seek to trim outer vehicle dimensions while maintaining or even expanding interior passenger and cargo space.

All of these manufacturers currently employ conventional rear-wheel-drive in their passenger vehicles and have not announced any plans to convert to front-wheel-drive. Conversion to front-wheel-drive may not significantly reduce vehicle weight in itself; however, the corporate fuel economy ratings would improve if consumers would accept a smaller car with front-wheel-drive if it produces equivalent interior volume to a larger car with rear-wheel-drive.

7.3.3 Major Sheet Metal Changes

A manufacturer can reduce vehicle weight by changing vehicle sheet metal while retaining vehicle dimensions. Although the impact on vehicle weight is not as great as in major redesign, the development and manufacturing costs are significantly less.

Sheet metal changes generally involve design modifications (in shape) or material substitution or reduction in gauge thickness on body panels, wheel well, hood, deck lid, fenders, and bumpers, while retaining major frame reference points as determined by the major vehicle support structure. Although certain of these components can be altered independently, overall resurfacing or reskinning of vehicles constitute major sheet metal changes.

So far, only Mercedes-Benz and BMW have announced plans to change sheet metal on various models. It is probable that Volvo and BL will also make such changes.

7.3.4 Token Weight Losses

Between years in which major vehicle redesigns are scheduled, manufacturers are expected to remove a certain amount of weight from various models in order to meet the annually increasing fuel economy standards. Usually performed independently of major styling changes, these methods include: substitution of redesigned or lighter weight components; equipment change from standard to optional; engine downsizing; and trim change. It is an effective technique for dropping a vehicle into the next lower inertia weight class in instances where a vehicle's weight is close to the dividing line.

Since few, if any, major vehicle changes have been announced by the import manufacturers, it is projected that most of the weight loss will involve token losses. Significant weight reduction is feasible through component alterations alone. The magnitude of the token weight losses has been formulated for each manufacturer's market class based on historical evidence and coordinated with the other weight reduction strategies described above.

a. Components

Many options are available to manufacturers in the area of component weight reduction through material substitution and/or parts redesign. Although each of these European manufacturers already use a small percentage of components made from lightweight materials, among them engine blocks or heads, bumpers, some sheet metal, many other options have yet to be exploited. Announced plans indicate expanded manufacture and use of lighter weight parts; BL's component group SU Butec is investigating aluminum radiators and Volvo plans shortly to open a component plant in Norway for production of aluminum and plastic parts.

Application of lighter weight and redesigned components by U.S. auto manufacturers exemplify many of the alternatives available to European manufacturers using currently accessible technology. Table A-5 illustrates the types of components which have been or can be altered individually by U.S. manufacturers, and the weight savings associated with the change using technology currently available or in the advanced development stages. This table was generated from extensive research and compilation of numerous data sources detailing changes by U.S. domestic manufacturers.

Table A-6, Applicable Import Component Changes, was derived from Table A-5 and contains a partial listing of the major components which offer the greatest weight reduction potential and would most likely be applied by import manufacturers. The total of 495 pounds (if all changes were enacted) does not include secondary weight losses which could be realized from lighter support systems normally included in major redesigns; nor does it include a large number of smaller components, such as aluminum rear engine cover plates or plastic trim panels or plastic brackets, which reduce weight by only a few pounds individually, but result in significant weight losses when aggregated. In addition, applications of new technologies will offer increased opportunities for piecemeal weight loss.

b. Spark Ignition versus Diesel Engines

Although diesel engines usually weigh more than comparable spark ignition engines, they offer considerably higher fuel economy ratings (up to 25% improvement). Most of the import manufacturers expect to introduce and/or expand diesel usage through the 1980's.

For corporate average fuel economy computations, it is more important and effective for manufacturers to upgrade the lower ratings of the gasoline models than to increase the higher diesel ratings. Although all manufacturers intend to refine and improve existing engine performance, as well as decrease aerodynamic drag and rolling resistance, weight reduction offers the greatest and most tangible benefits towards improved fuel economy. Some of the additional weight loss required for non-diesel models can be removed by certain engine modifications (such as thin walled castings) which are not applicable to diesel engines. Diesels require heavier block structure to withstand the stress of higher compression ratios and also need oversize supporting systems (i.e., radiator, starter, batter, engine mounts, etc.).

7.4 Manufacturers' Individual Strategies

Master Product Schedules were developed for the major import manufacturers under Contract DOT/TSC-1383 by Corporate-Tech Planning and later updated for NHTSA. The schedules identify, to the extent known and publicly announced, new vehicle introductions, major sheet metal and styling changes, and significant technological advances in the areas of engines, transmissions and material substitution by make, model and year from 1975 to 1985. In actuality, few definitive import plans are known past 1980, but the product schedules were used to the extent possible. Most of the effort in this analysis then concentrated on extrapolating from the methodology developed for the weight reduction analysis of U.S. domestic manufacturers.

The specific weight reduction strategies to be employed by each import manufacturer reflect use of as much known information about the manufacturers' announced future product plans combined with an assessment of the feasible weight loss using the weight reduction options described in Section 7.3. Since each of these importers offers its own limited line(s) of vehicle which do not necessarily compete head-to-head with other manufacturers' vehicles, manufacturer-specific details regarding weight reduction must be taken into account.

7.4.1 Mercedes-Benz

Although Mercedes' expects to increase its current mix of diesel powered models from 53%, substantial weight loss may be needed to meet the 1985 CAFE requirements. Furthermore, Mercedes' dominance in passenger car diesel sales is being challenged by the recent diesel offerings from General Motors, domestically, and other European manufacturers.

In formulating the annual weight losses, consideration was given to a variety of factors including vehicle size, historical company actions, announced plans affecting product lines and manufacturing facilities, engine type, plus anticipated component modifications per Table A-6.

A strategy for weight reduction using a combination of all weight reduction methods is illustrated in Table 7-1.

Announced plans for Mercedes-Benz include introduction of spark ignition and diesel versions of a station wagon in 1979 (1); and one downsizing of each of its current series (123, 116, 107) between 1981 and 1985. The reported weight loss expected from the vehicle downsizing approximates 450 pounds or 11.5% of the current (1978) 3850 pound average vehicle weight. This is readily achievable by use of smaller engines, frame, and chassis components with minimal material substitution and component redesign (2).

Further weight reduction could be accomplished through substantial component redesign and material substitution which would supplement dimensional downsizing and contribute towards incremental weight reduction during carryover years.

In 1978 Mercedes-Benz installed an aluminum engine, hood, decklid and wheels on its German 450 SLC 5.0 model which resulted in a 200 pound weight loss (3). Referring to Table 7-1, similar engine and sheet metal changes may be feasible for U.S. models by 1980. Spark ignition models reflect the total 200 pound weight loss whereas diesel versions would lose about 100 pounds (through sheet metal changes only).

By carefully assessing the factors described above, substantial weight loss could also be realized inthe 1980's in years other than announced vehicle downsizing. It is anticipated that 100 pounds per year could be removed from the spark ignition 116 and 107 series vehicles and 60 pounds per year from the diesel versions. Since the weights of the 123 series vehicles

TABLE 7-1

MERCEDES BENZ WEIGHT LOSS STRATEGIES BY SERIES

SERIES	ENGINE	1979	1980	1981	1982	1983	1984	1985	1986
123/170	Spark Ignition	Carryover	200 lbs.		90 lbs.			450 lbs* less than 1978 plus token wt. loss since 1981	Carryover
	Diesel	Carryover	100 lbs.		55 lbs.				
116/126 (and 450 SLC)	Spark Ignition	Carryover	200 lbs.	11.5% less* wt. than 1978 model			100 lbs.		
	Diesel	Carryover	100 lbs.				60 lbs.		
107 (450 SL)	Spark Ignition	Carryover	200 lbs.	100 lbs.		11.5% less* than 1978 plus token wt. loss since 1981		100 lbs.	
Wagon	Spark Ignition/ Diesel	New	75 lbs. (avg.)						

* New downsized vehicles.

average about 90% of the 116 series weights; the token weight losses have been apportioned accordingly since many components vary with vehicle size - 90 pounds per year weight loss from spark ignition models and 55 pounds per year for diesel models. The downsized 107 series in 1983 (450 SL) could result in an 11½% reduction over 1978 weight plus the accumulated token weight of 200 pounds during the interim 1981-1982 period.

7.4.2 BMW

Weight reduction strategies for BMW, Volvo and BL are summarized in Table 7-2, since each company offers fewer models and has more limited announced product plans than Mercedes-Benz.

BMW has introduced its 320i, 630Csi, and 733i models in the U.S. during the past rhree years and will replace the 530i model with the 528i model in 1979 (4). As such, replacement models are not expected until at least the mid-1980's.

Weights of all 1978 vehicles were reduced 150 to 200 pounds (about 5.5%) through running changes during the model year, presumably through selected sheet metal changes (5). Curb weight for 1979 models reflect these changes.

Although BMW is developing diesel and turbodiesel engines for use in selected models in the early 1980's to boost fuel economy ratings, additional weight losses may also be needed to meet 1986 fuel economy goals (6). No consideration has been given to diesel models by weight since specific applications and engine sizes have not been reported.

Token weight losses formulated for 1980-1986 model years reflect extensive analysis of potential component modifications through redesign and material substitution, announced product and production plans, correlated with vehicle size. Losses of 100 pounds per year are projected for the heavier 5, 6, and 7 series vehicles and 75 pounds per year for the proportionately lighter 3 and 4 series vehicles (to be introduced). Since all BMW models are equipped with aluminum block engines, other components are candidates for weight reduction.

TABLE 7-2

IMPORT WEIGHT LOSS STRATEGIES

MANUFACTURER	WEIGHT LOSS STRATEGIES: Major Vehicle Redesign	Major Sheet Metal Change (%)	Token Weight (lbs./yr)
Mercedes-Benz			
Spark Ignition	11½% + token weight	5%	90-100
Diesel	11½% + token weight	2.5%	55-75
BMW			
3 and 4 Series	*	5.5%	75
5, 6, and 7 Series	*	5.5%	100
British Leyland			
MG, Triumph, Rover	*	*	50
Jaguar	*	*	150
Volvo			
240 Series	*	*	110
260 Series	*	*	125
Diesels	*	*	110

* No announced plans.

7.4.3 Volvo

Since Volvo's 1978 Corporate Average Fuel Economy (CAFE) rating of over 21 mpg could meet the 1980 standards with the current model line, no changes are required for 1979 and 1980 vehicles.

Volvo will introduce six cylinder diesel sedans and wagons to the U.S. market in 1980 (7). Based on fuel economy ratings of 19 mpg of current six cylinder spark ignition models, diesel ratings will probably be in the range of 23-24 mpg. This would improve Volvo's CAFE but still leave it short of the 1985 standard without further vehicle improvements.

Since Volvo has not announced any other major redimensioning of its vehicles or changes in product line offerings, it is anticipated that substantial weight will be removed from existing vehicles on a piecemeal basis in order to meet fuel economy standards in the 1980's. Although no plans have been announced yet, Volvo will probably incorporate major sheet metal changes in its future plans since U.S. domestic manufacturers and other European manufacturers have obtained weight losses of 5-10% from such modifications. Volvo will expand development of many lightweight components when it completes a plant in Norway for aluminum and plastic components (8). Volvo's current models already have an aluminum alloy cylinder head engine, but have a cast iron cylinder block and unit steel frame. Extensive evaluation of a variety of factors impacting on weight reduction efforts indicate feasible token weight losses for 1981-1986 averaging 110 pounds per year for diesel models and 240 series, and 125 pounds per year for the somewhat heavier 260 series.

7.4.4 BL Ltd.

BL has no announced plans to introduce diesel engines to the U.S. market by 1985 nor to downsize or replace modesl currently sold. With a 1978 CAFE exceeding 21 mpg, BL could meet 1980 standards without modifying current offerings.

Two new models are scheduled for introduction in 1979 (TR8) and 1980 (Rover 3500) but no reports indicate fuel economy ratings for these new models (9).

If BL is to meet fuel economy for 1981 and beyond, substantial weight reduction programs must be initiated. BL's models are very heavy and fuel inefficient compared to U.S. models of equivalent size and weight, especially the Jaguars. Even though Jaguar sales constitute only 3% or so of BL's total U.S. sales, the extremely poor fuel economy ratings of 11-16 mpg impact adversely on the corporate average and need to be improved greatly to keep them as viable products.

Since BL has not announced plans to redimension its current U.S. offerings, weight loss programs would probably focus on piecemeal alterations. Included in these token weight losses would be probable lighter weight components via parts redesign and material substitution, as well as sheet metal changes, which have yielded weight loss benefits of 5-10% for U.S. domestic manufacturers and other European manufacturers. BL already uses aluminum engine blocks and cylinder heads, and its component group is investing heavily in development of aluminum radiators, among other parts. Extensive evaluation of feasible component modifications correlated with current vehicle weights suggests annual token weight losses of 50 pounds per year for the 2-Seater models (MG, Triumph) and the new Rover, and 150 pounds per year for the heavy Jaguars for the 1980-1986 timeframe.

7.5 Results

The results of this analysis are presented at two levels of detail. Vehicle weight ranges for sedans and station wagons were projected for each model for model years 1979 through 1986 emplying the individual weight reduction strategies formulated for each manufacturer in Table 7-2. Summary charts were then generated which project weights of sedans by market class according to EPA classifications. The projections are based on information current through November 1978.

7.5.1 Projected Curb Weights by Model and Year

Tables A-7 through A-10 project vehicle weights by manufacturer for 1979 through 1986 model years utilizing strategy combinations of major redisign, all new sheet metal, and component and material substitution against 1978 baseline data.

Four place weight data is carried through the tabulation (rather than rounding off to the nearest 50 pounds) for the purpose of audit and to prevent compounding of errors as the weight reduction tabulation progressed sequentially out to 1985. A round off to the nearest 50 pounds would be appropriate precision in regarding any of the data.

a. Mercedes-Benz

The results of Mercedes weight projections by series and model are contained in Table A-7 by applying strategies discussed in Section 7.4.3 and Table 7-7. An example of weight reduction strategy application is illustrated by the downsizing of the 450 SL model (in 107 Series) in 1983. The weight loss will be approximately 11.5% of the 1978 curb weight due to the smaller engine and vehicle dimensions. Between 1980 and 1982, however, certain component changes to the 450 SL are anticipated. Sheet metal changes feasible for 1980 could reduce the weight of the current model by 100 pounds; this modification is included in the 1983 redesign 11.5% weight loss. In 1981 and 1982, additional component redesign and material substitution could further reduce vehicle weight by about 100 pounds each year; these changes would supplement the 11.5% so the total weight loss in

1983 would be 11.5% less than 1978 curb weight plus 1981 and 1982 token weight losses.

Weight losses for the 123 Series vehicles follow the strategies displayed in Table 7-1. 1979 vehicles are essentially carryovers, although the 230 will be discontinued. Sheet metal changes and engine changes feasible for 1980 would reduce the weight of spark ignition models (280 CE, 280 E) by 200 pounds, and the weight of diesel models (240 D, 300 D, 300 CD) by 100 pounds. From 1981-1984 token weight losses of 90 pounds per year are estimated for spark ignition models and 55 pounds per year for diesel models.

In 1985, all 123 models will be replaced by 170 Series models which will have smaller vehicle dimensions. The expected engine offerings for the 170 Series will include a 1.7 liter 4-cylinder, 2 liter 4-cylinder, 2.3 liter 6-cylinder, and 2 diesel options (compared with current 2.3 liter, 2.4 liter diesel, 2.8 liter, and 3.0 liter diesel). Vehicle weights for the 170 Series are estimated at 2410-2800; this includes an 11.5% weight loss from the 1978 123 models due to smaller frame, chassis, engine components plus most of the token weight losses accumulated in the 123 models from 1981-1984. Token weight losses are accumulated under the assumption that component changes and improved technology applied to the 123 models between 1980 and 1984 will be continued in the newer 170 Series.

Mercedes will introduce a wagon in spark ignition and diesel versions in 1979 which will share the 110" wheelbase chassis with the 123 Series sedans. Up to 5 engines may be offered - 2.3 liter, 2.5 liter, 2.8 liter spark ignition and 2.4 liter and 3.0 liter diesels. The average curb weight for a U.S. domestic wagon is generally 250 pounds heavier than the average curb weight for a sedan version of the same model. Based on this, the average curb weight for the Mercedes' wagon is estimated at 3750 pounds, or 250 pounds more than the average 3500 pound 123 Series sedan.

Additional component modifications may be feasible from 1980-1986 which could result in token weight losses of about 75 pounds per year.

b. BMW

The results of this analysis for BMW are displayed in Table A-8 employing the strategies discussed in Section 7.4.4 and Table 7-2.

Selected sheet metal changes applied as running changes in 1978, which reduced vehicle weight 150-200 pounds (about 5.5%), are reflected in the 1979 curb weights. Except for the replacement of the 530i model with the 528i model in 1979 and the addition of a hatchback/fastback version of the 320i in 1980, retention of current BMW models is anticipated. Projected curb weights in 1980-1986 reflect application of estimated token weight losses from Table 7-2.

c. Volvo

Projected curb weights by model for 1978-1986 for Volvo, using the strategies discussed in Section 7.4.5 and Table 7-2, are presented in Table A-9.

No weight loss is required for Volvo to meet 1980 CAFE standards; therefore, weight loss strategies are applied from 1981-1986. Since no specific major vehicle redesigns have been announced, Volvo's weight reduction program will likely be piecemeal as reflected in the annual token weight losses.

Volvo will introduce a diesel sedan and station wagon to the U.S. market in 1980. Powered by a VW built 2.4 liter in-line 6 cylinder diesel, the sedan weight is estimated to be 3300 pounds and the wagon weight to be 3500 pounds, or 150 and 250 pounds heavier than the current 260 series 2.7 liter V-7 spark ignition sedan and wagon, respectively. These differences are based on comparable differences attained by other manufacturers offering diesel and spark ignition models, such as Peugeot's 2 liter and 2.3 liter 4 cylinder engines and Oldsmobiles's 5.7 liter (350 CID V-8) and 4.3 liter (260 CID V-8) engines. The heavier weight of diesel models can be tolerated due to the higher fuel economy ratings achievable. However, since the fuel economy ratings of Volvo's diesel models will fall short of the 1985 CAFE standard, token weight reduction in other areas would benefit the end result. Token weight losses of 110 pounds per year (equal to that expected for Volvo's lighter series of vehicles) would be feasible for the diesel models for the 1981-1986 period.

d. BL

Table A-10 contains the projected curb weights for BL by model for 1978-1986 based on weight reduction strategies formulated in Section 7.4.6 and Table 7-2.

Weights of 1978 models will likely remain the same through 1979 since BL could meet 1979 CAFE requirements with the current fleet. U.S. introduction of the 2-Seater TR8 model is planned for 1979. The TR8 will share the body with the TR7 (85 inch wheelbase) but will be equipped with an aluminum V-8 engine, versus the TR8 in-line 4 cylinder 122 CID engine (8). It is estimated that the TR8 will weigh 2700 pounds, or about 250 pounds more than the TR7 due to the larger engine based on weight differentials between U.S. cars with similar sized engine options, such as the Ford Fairmont.

In 1980, BL will introduce the Rover 3500 4 door hatchback to the U.S. market. It replaces a previous Rover model dropped in 1977 which weighed 2320 pounds and was equipped with a 2 liter 4 cylinder engine (9). It is estimated that the Rover 3500 model with a larger 3.5 liter V-8 engine will weigh about 2600 pounds. Token weight losses of 50 pounds per year would be feasible for 1981-1986.

Although BL could meet 1980 CAFE standards with the current fleet, some modifications are feasible for 1980 models. As no difinitive plans regarding major vehicle redesigns have been announced, BL's anticipated weight reduction efforts for model years 1980-1986 will focus on token weight losses, as discussed in Section 7.4.6. For example, the curb weight of the MG Midget could be reduced 50 pounds per year from 1980 through 1986.

7.5.2 Average Sedan Weight Summaries

The significance of this analysis may best be presented at the summary level of detail for several reasons:

1. By computing an average of all vehicles in a series, the effect of one model disappearing before 1986 would have less impact on the overall weight reduction trend (and thereby reduce errors) than if an attempt was made to assess any one individual model by itself.
2. The general trend in weight reduction is more easily observed over a period of time by tracking the composite of several vehicles in a series.
3. By graphically plotting the average weight of a series, the impact of individual manufacturer plans and strategies on weight projections over time are easier to observe. Furthermore, since each manufacturer has its own strategy, a slip in time can be expressed and observed more easily by a change in slope.

Average weights by EPA market class and series have been computed for each manufacturer in Tables A-11 through A-14 (arithmetic averages, not production weighted averages). These average weights were then plotted by EPA market class on Figures 7-1 through 7-3; symbolic triangles highlight new car introductions and major redesigns.

Tables A-11 through A-14 have been arranged to reflect the 1978 EPA market classification in order to be consistent with the EPA/DOE Consumer Mileage Guide. The EPA categorizes vehicles into market classes according to an interior volume index (expressed in cubic feet) which is based on standard dimensional references -- head room, hip room, leg room, shoulder room -- for the front and rear seats as well as trunk capacity, as opposed to weight classifications per se. Caution must be exercised in using EPA classifications, however, since they are subject to change -- models may shift EPA classes from one year to the next. Although the curb weight projected for a given model in a given year will not change if the model shifts EPA classes, the summary figures will change annually if many models switch classes. The summary projections retained the 1978 EPA market classifications through 1986.

All manufacturers are not represented on each summary chart since each offers a limited product line which does not include models in every EPA class. For instance, none of the four importers offer "large" cars (over 120 cubic feet of passenger and luggage space), only one (Mercedes-Benz) offers midsize cars, and one (Volvo) offers vehicles only in the compact class.

Strategies discussed in Section 7.4 are based on the weight which could be removed from vehicle series as viewed by the manufacturer, not on interior volume. It is reduced vehicle weight from which fuel economy gains will be manifested; volume will help in total vehicle utility in terms of payload characteristics. With weights projected on a yearly basis, fuel economy gains can then be combined with vehicle volume to arrive at some overall vehicle efficiency index.

a. Mercedes-Benz

The weights of all individual model projections in a given series were averaged by year (Table A-11) and the values plotted on Figures 7-1 and 7-2. In Figure 7-1, the large drop in average weight of midsize vehicles (116 V Series) in 1980 is attributed in part to the sheet metal and engine changes to the 450 SEL model and in part to the discontinuation of the much heavier 450 SEL 6.9 model due to adverse effects on CAFE. The drop in 1981 average midsize weight represents replacement of the 116 Series by the downsized 126 Series. From 1980 on, the only midsize vehicle offered is the 450 SEL and its successor.

The 2-Seater class average weight, also plotted in Figure 7-1, was computed from the 450 SLC and 450 SL models. Only the 450 SLC will be downsized in 1981 and only the 450 SL will be downsized in 1983; therefore, the large weight loss estimated from downsizing one model is off set somewhat when averaged with the smaller token weight losses applied to the other model.

Two Mercedes-Benz vehicle series (116 and 123) classify as compact vehicles, with average weights plotted by year in Figure 7-2. The sharper slope on the 116 series line in 1980 reflects projected sheet metal and engine component changes. In 1981, the 116 series vehicles will be replaced by downsized vehicles which is also reflected in a sharp slope. From 1982-1986, projected token weight losses reduce average weight by an equal amount each year.

In 1979, the lighter 230 model will be discontinued, thereby increasing the average weight of the 123 series. Changes in engine components and sheet metal feasible for 1980 form a dip in the curve; token weight losses estimated for 1981-1984 are indicated by a straight line with a smaller slope; and replacement of the 123 series with the downsized 170 series in 1985 shows a discontinuity in the curve.

b. BMW

Table A-13 contains BMW average sedan weights by series. Since BMW offers only one model in the U.S. in each of the 5, 6, and 7 Series, those averages are identical to individual model projections in Table A-8. Series 3 and 4 are averaged in Table A-13 since the 4 Series hatchback will be a direct derivative of the 3 Series 2 door model.

The average sedan weights have been plotted by EPA class in Figure 7-2 (Series 7 - Compact) and Figure 7-3 (Series 3 and 4, 5, 6 - Subcompact). Between 1978 and 1979 the slightly steeper slope of all the lines reflects the sheet metal changes applied during the 1978 model year. Other than the addition of the 4-Series model in 1980, the lines decline in equal decrements of the annual token weight losses anticipated.

c. Volvo

Both the 240 and 260 Series share the same body and provide 103 cubic feet of passenger and luggage volume so the EPA classifies all of Volvo's sedans and coupes as compact cars. The average weight of sedans and coupes for each series by year is displayed in Table A-14 and the values plotted in Figure 7-2.

Since no weight reduction is required before 1981, the weights of current models are constant for the period 1978-1980, as reflected in the horizontal line for the 240 Series in Figure 7-2 from 1978-1980. The average weight for the 260 Series increases slightly in 1980 due to the addition of a heavier diesel sedan; however, because the increase is averaged over three vehicles (260 diesel, 264, 262), two of which remain constant, the 1980 average increment in less than the absolute weight difference between the diesel and spark ignition sedans.

The 240 and 260 lines converge somewhat from 1980 to 1986 due to the larger token weight losses proposed for the 260 Series.

d. BL

The average weights of all individual model projections in a given EPA market class have been computed and are displayed by year in Table A-14; the values were plotted in Figures 7-1, 7-2, and 7-3.

Referring to Figure 7-1, the 1979 average weight of the 2-Seater class increases somewhat due to the addition of a heavier TR8 model. When only one model in the class changes, the weight increment is averaged out over the entire market class so the effect of a weight change is less. From 1981 through 1986, however, all the models may undergo comparable token weight losses as represented by the straight line in Figure 7-1.

BL's compact class contains two models in 1978 and 1979 and three models from 1980 through 1986 due to the introduction of the Rover 3500. As illustrated in Figure 7-2, the 1980 average weight drops markedly with the addition of the lightweight Rover 3500 even though the other two vehicles may only undergo token weight losses. This is because the 1980 Rover will weigh not quite two thirds of the projected 1980 weight of each of the other two vehicles in the class (Rover = 2600 pounds, Jaguars average 4000 pounds each). From 1981 through 1986, uniform weight losses are anticipated for the class which represent an average of the token weight losses projected for the Rover and the two Jaguar models.

Since the Jaguar XJS is the only model in the subcompact class, the average weight for the class is identical to the projected curb weight for that model for a given year, as shown by comparing Tables A-10 and A-14, and plotted in Figure 7-3.

FIGURE 7-1

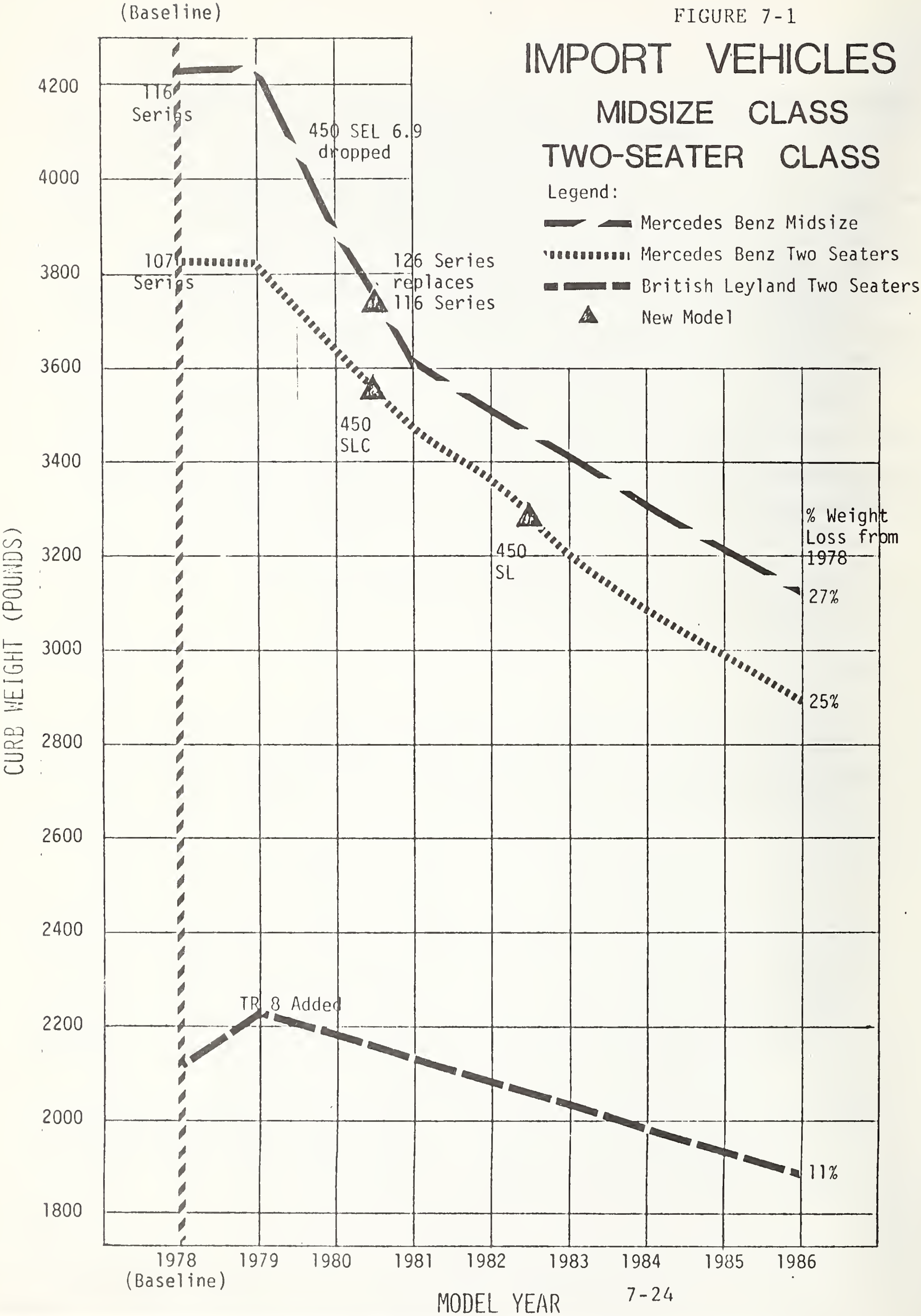

IMPORT VEHICLES
MIDSIZE CLASS
TWO-SEATER CLASS
Legend:
Mercedes Benz Midsize
Mercedes Benz Two Seaters
British Leyland Two Seaters
New Model
(Baseline)
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
CURB WEIGHT (POUNDS)
116 Series
450 SEL 6.9 dropped
107 Series
126 Series replaces 116 Series
450 SLC
450 SL
% Weight Loss from 1978
27%
25%
TR 8 Added
11%
1978 (Baseline)
1979
1980
1981
1982
1983
1984
1985
1986
MODEL YEAR

FIGURE 7-2

IMPORT COMPACT VEHICLES

(Average Weight by Year)

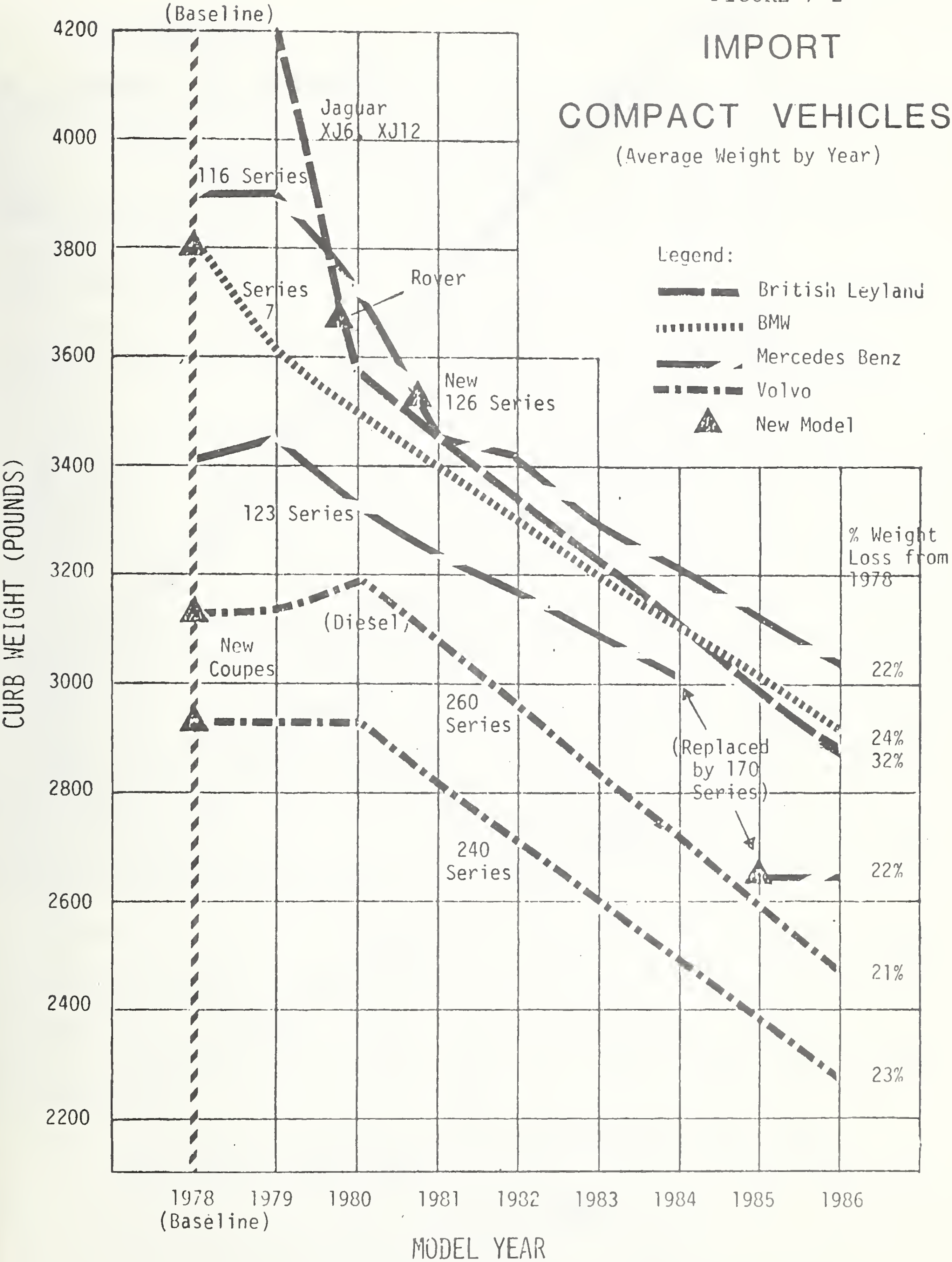
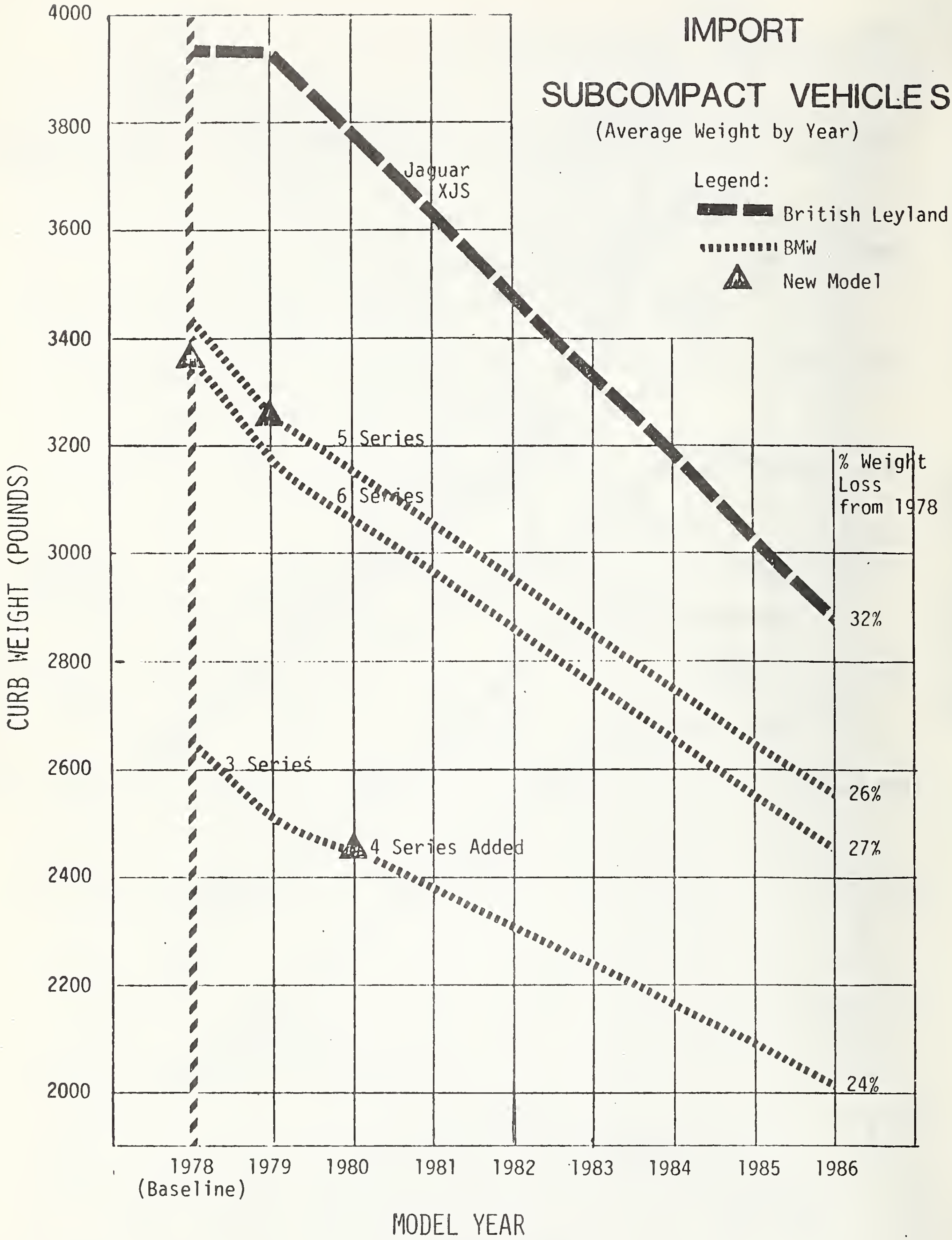


FIGURE 7-3


IMPORT
SUBCOMPACT VEHICLES
(Average Weight by Year)
Legend:
British Leyland
BMW
New Model
CURB WEIGHT (POUNDS)
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
Jaguar XJS
5 Series
6 Series
3 Series
4 Series Added
% Weight Loss from 1978
32%
26%
27%
24%
1978 (Baseline)
1979
1980
1981
1982
1983
1984
1985
1986
MODEL YEAR

7.6 Conclusions

Each manufacturer will likely employ a significantly different strategy to attain weight reduction goals with regard to product planning cycles, resulting in different magnitudes of weight loss apportioned to major vehicle changes and token weight losses. Even so, about the same percent weight loss (21-27) is expected for most models within the same market class, as summarized in Table 7-3.

Referring to Table 7-3, it is important to recall that most market classes contain relatively few models or sometimes only one model; hence, the deletion or addition of even one heavier or lighter model after 1978 significantly impacts the average weight of the class. From Table 7-3 it appears that the weight loss potential for most of these vehicles is between 625 and 950 pounds which would result in an average weight below 3000 pounds for most series.

It also appears that these import manufacturers could come close to meeting fuel economy goals via proposed weight reduction efforts alone, if they chose to pursue it. However, in order to actually meet the standards, additional technological improvements in such areas as engine performance, lubricants, aerodynamic drag, and rolling resistance would likely be applied. This is particularly critical for those importers who offer a limited product line, and, therefore, do not have lighter and more fuel efficient models to offset heavier models.

These projections are based on an assessment of currently available information regarding product plans, technological, financial and manufacturing capabilities. A "business as usual" economic environment is assumed. Factors impacting on vehicle weights for classifications which may alter these projections include:

1. Any delay in product plans for new designs or introduction of smaller engines;

2. Vehicles shifting between EPA market classes;

3. Shift of equipment offering from standard to optional (or vice versa) thereby altering the base curb weight;

4. Changes in other government regulations (i.e., emissions and safety) which impact on import manufacturers' product plans; and

5. Major setback in U.S. or domestic economy, abnormal inflation, or prolonged labor unrest (i.e., dock strike) which would adversely affect import sales.

TABLE 7-3

PROJECTED WEIGHT REDUCTION

BY MANUFACTURER

MANUFACTURER	SERIES	EPA MARKET CLASS	% WT LOSS 1978-1986	AVG. WT. 1978 (LBS)	AVG. WT. 1986 (LBS)	ΔWT 1978-1986 (LBS)
Mercedes-Benz	107	Two-Seater	25	3838	2893	945
	123/170	Compact	22	3409	2650	719
	116/126	Compact	22	3895	3045	850
	116V/126	Midsize	27	4235	3110	1125
BMW	3, 4	Subcompact	24	2650	2013	637
	5	Subcompact	26	3440	2550	890
	6	Subcompact	27	3360	2450	910
	7	Compact	24	3800	2900	900
Volvo	240	Compact	23	2926	2266	660
	260	Compact	21	3141	2474	667
British Leyland	MG, Triumph	Two-Seater	11	2117	1884	233
	Jaguar	Subcompact	27	3936	2886	1050
	Jaguar, Rover	Compact	32	4201	2867	1334

7.7 References

(1) Automotive News 8/8/78 p. 1.
Ward's Engine Update 7/7/78 p. 8.
Popular Science 1/78 p. 67.

(2) Automotive News 12/27/77 p. 1.

(3) Automotive Engineering 3/78 p. 14.

(4) Automotive News 10/16/78 p. 1.

(5) Automotive News 4/17/78 p. 36.

(6) Ward's Auto Reports 7/31/78 p. 1.
Ward's Engine Update 5/27/77 p. 1.
Automotive News 5/29/78 p. 1
7/24/78 p. 21.

(7) Automotive News 10/23/78 p. 45.

(8) Automotive News 5/29/78 p. 1.

(9) Ward's Auto Reports 3/27/78 p. 100.
Automotive News 1/2/78 p. 1

APPENDIX A. SUPPORT DOCUMENTATION FOR WEIGHT REDUCTION

TABLE A-1. MERCEDES-BENZ 1978 MODEL LINE

MODEL	WHEELBASE	ENGINE/TRANS (1)	CURB WT. (lbs)	1978 EPA MPG COMB/ CLASS	COMPARABLE U.S. CAR (by Wt.)	WT. U.S. CAR (lbs) LOADED	1978 EPA MPG COMBINED/ TRANSMISSION
123 Series							
230 Sedan	110"	2.3L/IL-4	3195	19/C	Fairmont	3200	22/A
240D Sedan	110"	2.4L/IL-4 Diesel	3210	29/C	Fairmont	3200	24/M
300D Sedan	110"	3.0L/IL-5 Diesel	3515	25/C	GM A-Body	3500	22/A
300CD Coupe	106.7"	3.0L/IL-5 Diesel	3495	25/C	GM A-Body	3500	22/A
280E Sedan	110"	2.8L/IL-6	3530	16/C	GM A-Body	3500	22/A
280CE Coupe	106.7"	2.8L/IL-6	3510	16/C	GM A-Body	3500	22/A
116 Series							
280SE Sedan	112.8"	2.8L/IL-6	3905	16/C	Diplomat	3900	18/A
300SD Sedan	112.8"	3.0/IL-5 Turbo-diesel	3885	26/C	Olds 88 Diesel	3900	24/A
450SEL Sedan	116.7"	4.5L/V-8	4080	14/M	Olds 98	4050	18/A
450 6.9 Sedan	116.5"	6.9L/V-8	4390	12/M	LTD II	4400	17/A
107 Series							
450 SL Coupe	96.9"	4.5L/V-8	3815	14/2-S	Corvette	3700	17/A
450 SLC Coupe	111"	4.5L/V-8	3860	14/2-S	Diplomat	3900	18/A

(1) Only Automatic transmission available on all models except 240D. On 240D, manual transmission is standard but automatic is available.

Transmission Type

M = Manual
A = Automatic

EPA Class

C = Compact
M = Midsize
2-S = 2-Seater

TABLE A-2. BMW 1978 MODEL LINE

MODEL	WHEELBASE	ENGINE/TRANS.	CURB WT. (lbs.)	1978 EPA MPG COMB/ CLASS	COMPARABLE U.S. CAR (by Wt.)	WT. U.S. CAR (lbs) LOADED	1978 EPA MPG COMBINED/ TRANSMISSION
320i	100.9"	2.0L/IL-4 4SP M	2650	22 (Subcompact)	Pinto	2800	29/M
530i	103.8"	3.0L/IL-6 4SP M	3440	17 (Subcompact)	Monte Carlo	3400	19/M
633Csi	103.4"	3.3L/IL-6 4SP M	3360	18 (Subcompact)	Monte Carlo	3400	19/M
733i	110.2"	3.3L/IL-6 4SP M	3800	18 (Compact)	Impala	3800	19/A

Standard Features

All: Aluminum alloy cylinder heads, gray iron cylinder blocks, aluminum die cast pistons, steel intake/exhaust manifolds.

530i, 633Csi, 733i: Air-conditioning standard.

Transmission Type

M = Manual
A = Automatic
Automatic Transmissions available.

TABLE A-3. VOLVO 1978 MODEL LINE

MODEL	WHEELBASE	ENGINE/ TRANS.	CURB WT. (lbs)	WT. OF OPTIONS (lbs)	1978 EPA MPG COMB/ CLASS	COMPARABLE U.S. CAR (by Wt.)	CURB WT. U.S. CAR (lbs.)	1978 EPA MPG COMB/ TRANS.
240 Series								
242 GT	104"	2.1L IL-4	2922	284 (1)	24/C	Ford		
242 DL	104"	(130 CID)	2906	284	24/C	Fairmont		
244	104"	Manual	2946	284	24/C	Sedan	2800	26/M
245	104"		3129	284	23/MW	Wagon	2900	26/M
260 Series								
262C	104"	2.7L V-6	3113	302 (1)	19/C	AMC Pacer		
264	104"	(163 CID)	3169	302	19/C	Sedan	3200	22/M
265	104"	Manual	3248	302	19/MW	Wagon	3250	22/M

Standard Features: Fuel injection, aluminum alloy cylinder head, cast iron cylinder block, unit steel frame.

(1) Options include air-conditioning, automatic transmission, power steering and brakes, radio, undercoat.

EPA Class

C = Compact
MW= Midsize Wagon

Transmission Type

M = Manual
A = Automatic

TABLE A-4. BRITISH LEYLAND 1978 MODEL LINE

MODEL	WHEELBASE	ENGINE/TRANS.	CURB WT. (lbs.)	1978 EPA MPG COMB/ CLASS	COMPARABLE U.S. CAR (by Wt.)	WT. U.S. CAR (lbs.) LOADED	1978 EPA MPG COMBINED/ TRANSMISSION
Jaguar							
XJS Coupe	102"	326CID/V-12 3 Sp. Auto.	3936	11 (Subcompact)	Buick	3950	18/A
XJ6L Sedan	112.8"	258 CID/IL-6 3 Sp. Auto	4068	16 (Compact)	Olds	4080	21/A
XJ12 Sedan	112.8"	326 CID/V-12 3 Sp. Auto	4344	11 (Compact)	LTD II	4400	17/A
MG							
MGB	91.1"	110 CID/IL-4 4 Sp. Manual	2338	20 (2-Seater)	Chevette	2260	34/M
Midget	80"	91 CID/IL-4 4 Sp. Manual	1826	26 (2-Seater)	Fiesta	1890	38/M
Triumph							
Spitfire	83"	91 CID/IL-4 4 Sp. Manual	1850	26 (2-Seater)	Fiesta	1890	38/M
TR-7	85"	122 CID/IL-4 5 Sp. Manual	2454	23 (2-Seater)	Omni	2375	29/M

Standard Features

All MG and Triumph: Aluminum alloy cylinder blocks and heads.
All Jaguars: Fuel injection, aluminum alloy cylinder heads, steel intake/exhaust manifolds, light alloy wheels, air-conditioning.
Jaguar XJS, XJ12: Aluminum alloy cylinder blocks.

Transmission Type

M = Manual
A = Automatic

TABLE A-5. U.S. DOMESTIC COMPONENT CHANGES

	Reference	Average Wt. Savings Per Vehicle (lbs.) (U.S. Midsize Car)
BRAKES		
Aluminum Master Brake Cylinder	(1)	6.5
Aluminum Rear Brake Drum	(2)	11.5
Power Brake Booster	(3)	3.5
Redesigned Disk Brake	(4)	4.5
Cast Iron Master Brake Cylinder/Nylon Reservoir	(5)	5
Redesigned Drum Brake	(6)	2.5
Aluminum Disk Brake	(7)	5
*BUMPERS (Weight Reduction from Mild Steel)		
RIM Flexible Bumpers	(8)	80
Aluminum Face Bar	(9)	38
Aluminum Reinforcement Bar	(10)	22
HSLA Steel Face Bumper (one piece)	(11)	30
SHEET METAL		
Hood: Plastic	(12)	10
* All Aluminum	(13)	25
High Strength Steel OUter	(14)	4
*Aluminum Deck Lids	(15)	25
*Plastic Fender Liners	(16)	10
*Soft Front End Header Panels	(17)	10
*Plastic Front Fender Skirts	(18)	9
CHASSIS		
Wheels: Aluminum Wheels	(19)	50
HSLA Steel Wheels	(20)	12.5
Door: Thinner door (remove rear window regulator)	(21)	36.5
* Aluminum outer panel/plastic inner panel	(22)	80
*Plastic Instrument Panel	(23)	6
Plastic Window Brackets	(24)	5

TABLE A-5. U.S. DOMESTIC COMPONENT CHANGES (Continued)

	Reference	Average Wt. Savings Per Vehicle (lbs.) (U.S. Midsize Car)
*Lightweight Rear Axles	(25)	18.5
Redesigned Rear Axles Hyooid Gears	(26)	2
Sill Area HSLA Steel	(27)	4
ENGINE/DRIVELINE		
Driveshaft and Leafspring (graphite fiber)	(28)	23.5
*Aluminum Intake Manifold	(29)	25.5
*Aluminum Water Pump	(30)	8
*Engine Block: Aluminum	(31)	93
Thin wall cast iron block	(32)	95
*Aluminum Cylinder Head	(33)	50/head
*Aluminum Rear Engine Cover Plates	(34)	1-2
*Aluminum Transmission Case	(35)	15
Clutch: Stamped Instead of Cast	(36)	12
Stamped Steel Bell Housing	(37)	14
Power Steering Pump (Variable Ratio)	(38)	5
*Plastic Fuel Tank	(39)	7
*Radiator Supports-Aluminum or Plastic	(40)	15
Plastic Front Seats	(41)	25
Air Conditioning Compressor	(42)	10
*Aluminum Cowl Vents	(43)	10
*Thinner Glass	(44)	15
Aluminum Radiators	(45)	10

* Most probable candidates for importers.

TABLE A-5. U.S. DOMESTIC COMPONENT CHANGES (Continued)

References

1.	AI	10/1/77	
2.	AE	5/77	p. 44
	WAR	8/29/77	p. 275
	WAW	9/77	p. 43
	AI	10/1/77	p. 24
3.	AI	11/15/77	
4.	AI	11/15/77	
5.	AN	2/27/78	p. 8
6.	AI	11/15/77	
7.	AE	5/77	p. 44
8.	AI	5/15/77	p. 13
	AN	8/29/77	p. 3
	AMM	4/18/77	p. 41
	AMM	4/24/78	p. 22
9.	WAR	2/77	p. 72
	WEU	4/14/78	p. 3
	WAW	10/77	p. 87
	WAW	5/77	p. 66
	AMM	7/4/77	p. 1
	AMM	5/23/77	p. 24
10.	AMM	6/20/77	p. 15
	AI	5/78	p. 53
	AMM	2/6/78	p. 10
	AI	10/1/77	p. 24
11.	AMM	6/20/77	p. 14
	AN	11/7/77	p. 38
	WAR	9/26/77	p. 206
	AMM	6/27/77	p. 1
12.	AN	2/27/78	p. 20
13.	AMM	4/25/77	p. 14
	WAR	1/3/77	p. 4
	AMM	4/11/77	p. 24
	WAW	4/78	p. 63
	AMM	1/30/78	p. 11
14.	AMM	3/6/78	p. 10
15.	AMM	7/25/77	p. 1
	AMM	6/20/77	p. 15
	AMM	5/22/78	p. 27
	AI	12/1/77	p. 26
16.	AMM	8/1/77	p. 5
17.	AMM	7/25/77	p. 1
	WAW	3/78	p. 115
	AI	10/1/77	p. 24
18.	AI	10/1/77	p. 24
	AMM	8/1/77	p. 5
	WAW	4/78	p. 64
19.	AI	4/1/77	p. 119 + 120
	AI	5/15/77	p. 32
	WAR	6/6/77	
	WAW	10/77	p. 82
20.	AN	3/27/78	p. 6
	AMM	2/6/78	p. 15
21.	AI	10/1/77	p. 24
22.	AI	3/15/77	p. 36
	AN	5/30/77	p. 8
	WAW	10/77	

TABLE A-5. U.S. DOMESTIC COMPONENT CHANGES (Concluded)

References

23.	AI	12/1/77	p. 23
24.	AMM	1/31/77	p. 7
	AI	12/1/77	p. 134
25.	WAR	9/26/77	p. 308
	WEU	6/10/77	p. 1
26	WAR	10/17/77	p. 331
27.	AMM	6/27/77	p. 11
28.	AI	7/1/77	p. 33
29.	WAW	4/78	p. 64
	AMM	12/19/77	p. 29
	AMM	12/12/77	p. 13
	AMM	8/29/77	p. 18
	WEU	9/16/77	p. 3
30	AMM	4/25/77	p. 13
31.	AMM	6/13/77	p. 37
	AE	6/77	p. 17
	WEU	6/10/77	p. 1, 8
32	WEU	6/10/77	p. 1
	AMM	6/13/77	p. 37
33.	WEU	6/1/77	p. 1
	AE	1/78	p. 32
34.	WEU	2/3/78	p. 7
	AMM	12/19/77	p. 11
35.	AI	7/1/77	p. 33
36.	AE	3/78	p. 22
37.	AI	7/1/77	p. 33
	AI	12/1/77	p. 49
38.	AE	10/77	p. 37
39.	AI	12/1/77	p. 76
	WAR	1/2/78	p. 5
	AI	1/1/78	p. 67
40.	AN	2/27/78	p. 20
	AMM	6/13/77	p. 41
	AN	7/77	p. 23
	ALCOA		
41.	AMM	6/27/77	p. 10
	AMM	1/3/77	p. 14
42.	AN	11/7/77	p. 38
43.	ALCOA		
44.	WAR	3/78	p. 59
	WAR	11/26/77	p. 279
45.	WAR	2/13/78	p. 50
	ALCOA		

TABLE A-6

APPLICABLE IMPORT COMPONENT CHANGES

Component Area	Average Weight Savings Per Vehicle (lbs.) (U.S. Midsize Car)
Bumpers	60
Combination of lightweight bumpers and face bars (plastic, aluminum, HSLA steel)	
Sheet Metal	
Aluminum hood	25
Aluminum deck lids	25
Plastic fender liners	10
Soft front end header panels	10
Plastic front fender skirts	9
Chassis	
Door: Aluminum outer panel/plastic inner panel	80
HSLA steel door beams	8
Plastic Instrument Panel	6
Lightweight rear axles	18.5
HSLA steel sill area	4
Engine/Driveline	
Aluminum intake manifold	25.5
Aluminum water pump	8
Engine block: Aluminum or thin wall cast iron	94
Aluminum cylinder head	50
Aluminum Transmission Case	15
Plastic Fuel tank	7
Radiator supports - aluminum or plastic	15
Aluminum cowl vents	10
Thinner glass	15
TOTAL (if all used)	495

TABLE A-7. MERCEDES-BENZ PROJECTED CURB WEIGHTS 1978-1986 11/1/78 MCI-CTP

MODEL	EPA MKT CLASS	1978 CURB WT	1978 EPA MPG (COMB)	1979 CURB WT	1980 CURB WT	1981 CURB WT	1982 CURB WT	1983 CURB WT	1984 CURB WT	1985 CURB WT	1986 CURB WT	△ WT 1978-1986
170 Series												
170		--		--	--	--	--	--	--	$\boxed{2410-2800}$	2410-2800	800
123 Series												
230	C	3195	19	--	--	--	--	--	--	--		
240D	C	3210	29	3210	3110	3055	3000	2945	2890	-- re-		
240D Turbo	C	--		--	--	--	--	2960	2905	- placed		
300D	C	3515	25	3515	3415	3360	3305	3250	3195	-- by		
300CD	C	3495	25	3495	3395	3340	3285	3230	3175	- 170		
280E	C	3530	16	3530	3330	3240	3150	3060	2970	-- Series		
280CE	C	3510	16	3510	3310	3220	3130	3040	2950	--		
116 Series												
280 SE	C	3905	16	3905	3705	$\boxed{3455}$	3355	3255	3155	3055	2955	950
300SD Turbo	C	3885	26	3885	3785	$\boxed{3435}$	3375	3315	3255	3195	3135	750
116V Series												
450 SEL	M	4080	14	4080	3880	$\boxed{3610}$	3510	3410	3310	3210	3110	970
450 6.9	M	4390	12	4390	--	--	--	--	--	--	--	
107 Series												
450SL	2	3815	14	3815	3615	3515	3415	$\boxed{3176}$	3076	2976	2876	939
450SLC	2	3860	14	3860	3660	$\boxed{3410}$	3310	3210	3110	3010	2910	950
Wagon												
TD				$\boxed{3750}$ (est.)	3550	3475	3400	3325	3250	3175	3100	
Corporate Average (Arithmetic)		3699	18.8									

$\boxed{}$ New model.

EPA CLASS
2 = 2-Seater
C = Compact (100-110 Cubic ft. passenger and luggage volume).
M = Midsize (110-120 cubic ft. passenger and luggage volume).
D = Diesel engine.

TABLE A-8. BMW PROJECTED CURB WEIGHTS 1978-1986 11/1/78 MCI-CTP

MODEL	EPA CLASS	1978 CURB WT	1978 EPA MPG (COMB)	1979 CURB WT	1980 CURB WT	1981 CURB WT	1982 CURB WT	1983 CURB WT	1984 CURB WT	1985 CURB WT	1986 CURB WT	Δ WT 1978-86
320i	S	2650	22	2500	2425	2350	2275	2200	2125	2050	1975	675
420	S	--		--	$\boxed{2500}$ (est.)	2425	2350	2275	2200	2125	2050	
530i/ 528i(1979)	S	3440	17	$\boxed{3250}$ (est.)	3150	3050	2950	2850	2750	2650	2550	890
633Csi	S	$\boxed{3360}$	18	3160	3060	2960	2860	2760	2660	2550	2450	910
733i	C	$\boxed{3800}$	18	3600	3500	3400	3300	3200	3100	3000	2900	900

Corporate Average (Arithmentic) 3313 18.8

$\boxed{}$ New Model

All weights in pounds.

EPA CLASS

S = Subcompact (85-100 cubic ft. passenger and luggage volume).
C = Compact (100-110 cubic ft. passenger and luggage volume).

TABLE A-9. VOLVO PROJECTED CURB WEIGHTS 1978-1986 11/1/78 MCI-CTP

MODEL	EPA CLASS	1978 CURB WT	1978 EPA MPG (COMB)	1979 CURB WT	1980 CURB WT	1981 CURB WT	1982 CURB WT	1983 CURB WT	1984 CURB WT	1985 CURB WT	1986 CURB WT	△ WT 1978-86
242GT Coupe	C	$\boxed{2922}$	24	2922	2922	2812	2702	2592	2482	2372	2262	660
242DL Coupe	C	2906	24	2906	2906	2796	2686	2576	2466	2356	2246	660
244 Sedan	C	2946	23	2946	2946	2836	2726	2616	2506	2396	2286	660
245 Wagon	MW	3129		3129	3129	3019	2909	2799	2689	2579	2469	660
262 Coupe	C	$\boxed{3113}$	19	3113	3113	2988	2863	2738	2613	2488	2363	750
264 Sedan	C	3169	19	3169	3169	3044	2919	2794	2669	2544	2419	750
265 Wagon	MW	3248		3248	3248	3123	2998	2873	2748	2623	2498	750
260D Sedan (Diesel)	C	--		--	$\boxed{3300}$ (est.)	3190	3080	2970	2860	2750	2640	660
260D Wagon (Diesel)	MW	--		--	$\boxed{3500}$ (est.)	3390	3280	3170	3060	2950	2840	660

Corporate Average 3085 over 21

$\boxed{}$ New model.

All weight in pounds.

EPA CLASS

C = Compact (100-110 cubic ft. of passenger and luggage volume).

MW= Midsize Wagon (130-160 cubic ft. of passenger and cargo volume).

D = Diesel.

TABLE A-10. BRITISH LEYLAND PROJECTED CURB WEIGHTS 1978-1986 11/1/78 MCI-CTP

MODEL	EPA CLASS	1978 CURB WT	1978 EFA MPG (COMB)	1979 CURB WT	1979 EPA MPG (COMB)	1980 CURB WT	1981 CURB WT	1982 CURB WT	1983 CURB WT	1984 CURB WT	1985 CURB WT	1986 CURB WT	△ WT 1978-86
MG Midget	2	1826	26	1826	26	1776	1726	1676	1626	1576	1526	1476	350
MGB	2	2338	20	2338	20	2288	2238	2188	2138	2088	2038	1988	350
Triumph Spitfire	2	1850	26	1850	26	1800	1750	1700	1650	1600	1550	1500	350
TR-7	2	2454	23	2454		2404	2354	2304	2254	2204	2154	2104	350
TR-8	2	--		$\boxed{2700}$ est.		2650	2600	2550	2500	2450	2400	2350	350
Jensen/ Rover	C	--		--		$\boxed{2600}$ est.	2550	2500	2450	2400	2350	2300	
Jaguar XJ6L	C	4068		4068	16	3918	3768	3618	3468	3318	3168	3018	1050
XJ12	C	4334		4334	11	4184	4034	3884	3734	3584	3434	3284	1050
XJS	S	3936		3936	11	3786	3636	3486	3336	3186	3036	2886	1050

Corporate Average (Arithmetic) 2972 > 21

☐ New Model

All weights in pounds

EPA CLASS

2 = 2-Seater
S = Subcompact (85-100 cubic ft. passenger and luggage volume).
C = Compact (100-110 cubic ft. passenger and luggage volume).

TABLE A-11. MERCEDES-BENZ AVERAGE WEIGHTS BY SERIES

Series	EPA Market Class	MODEL YEAR 1978	1979	1980	1981	1982	1983	1984	1985	1986
107	2-Seater	3838	3838	3638	3463	3363	3193	3093	2993	2893
123	Compact	3409	3452 (1)	3312	3243	3174	3081	3014	2650	2650
116	Compact	3895	3895	3745	3445	3365	3285	3205	3125	3045
116V	Midsize	4235	4235	3880 (2)	3610	3510	3410	3310	3210	3110

(1) 230 Discontinued.

(2) 450 SLC 6.9 Discontinued.

New Models.

TABLE A-12. BMW AVERAGE WEIGHTS BY SERIES

MODEL YEAR

Series	EPA Market Class	1978	1979	1980	1981	1982	1983	1984	1985	1986
3, 4	Subcompact	2650	2500	2463 (1)	2388	2313	2238	2163	2088	2013
5	Subcompact	3440	$\boxed{3250}$ (2)	3150	3050	2950	2850	2750	2650	2550
6	Subcompact	$\boxed{3360}$	3160	3060	2960	2860	2760	2660	2550	2450
7	Compact	$\boxed{3800}$	3600	3500	3400	3300	3200	3100	3000	2900

(1) 4 Series Added.

(2) 528i replaces 530i.

$\boxed{}$ New model.

TABLE A-13. VOLVO AVERAGE WEIGHTS BY SERIES

MODEL YEAR

Series	EPA Market Class	1978	1979	1980	1981	1982	1983	1984	1985	1986
240	Compact	2926	2926	2926	2816	2706	2596	2486	2376	2266
260	Compact	3141	3141	3194 (1)	3074	2954	2834	2714	2594	2474

(1) Diesel added.

TABLE A-14. BRITISH LEYLAND AVERAGE WEIGHTS BY MARKET CLASS

MODEL YEAR

Models	EPA Market Class	1978	1979	1980	1981	1982	1983	1984	1985	1986
MG Triumph	2-Seaters	2117	2234 (1)	2184	2134	2084	2034	1984	1934	1884
Jaguar XJS	Subcompact	3936	3936	3786	3636	3486	3336	3186	3036	2886
Jaguar XJ6, XJ12, Rover	Compact	4201	4201	3567 (2)	3451	3334	3217	3101	2984	2867

(1) TR8 Added.

(2) Rover Added.

APPENDIX B

REPORT OF INVENTIONS

Under a thorough review of the work performed under this contract, no new innovations, discoveries, improvements or inventions were made or patents submitted.

The program did result in a better understanding of the four import manufacturers profiled and their capacity to meet fuel economy goals through an analysis of potential weight reduction.