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AUTOMOTIVE MANUFACTURING ASSESSMENT SYSTEM
VOLUME III: MATERIALS - WEIGHT ANALYSIS

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275 Wyman Street
Waltham, MA 02154

NOVEMBER 1979

FINAL REPORT

Transportation Systems Center
3

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16. Abstract
Volume III, Materials-Weight Analysis, is part of a four volume set documenting areas of research resulting from the development of the Automotive Manufacturing Assessment System (AMAS) for the DOT/Transportation Systems Center. AMAS was designed to assist in the evaluation of industry capability to produce fuel efficient vehicles. Through extensive research and synthesis of publicly available information, detailed abstracts and summaries were generated to describe material applications to automotive vehicles and components with emphasis on technological advances and weight reduction potential for each domestic auto manufacturer, material, and component area. Investigation focuses on analyzing factors affected by fuel economy efforts: current and innovative materials and their component applications; auto manufacturers' and suppliers' development programs; tooling/manufacturing processes; weight savings and fuel economy benefits; and costs involved. Weight reduction progress in the 1977 and 1978 model years is highlighted but announced future plans for each manufacturer are also presented.

Volume I, Master Product Schedules, portrays, chronologically, current and future product changes and technological advances for each domestic auto (1975-85), light truck (1975-80), and selected import manufacturers (1975-80).

Volume II, Product Schedules Of Engine/Driveline Combinations, identifies the available engine, transmission, and rear axle combinations for all models of each domestic auto manufacturer for the model years 1975 through 1978.

Volume IV, Engine Manufacturing Analysis, describes a complex modern high volume engine production facility (Ford Windsor Engine Plant) and assesses the impact of year-to-year model changes and government regulatory action on the manufacturing process.

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PREFACE

Volume III (Materials-Weight Analysis) was prepared for the Department of Transportation, Transportation Systems Center (TSC) and presents the results of research and analysis of innovative materials and component designs used by auto manufacturers to reduce vehicle weight. The work was directed by the Transportation Industry Analysis Branch under the sponsorship of the Energy Programs Division.

The motor vehicle manufacturers ability to meet 1979-1985 fuel economy goals is heavily dependent upon the timeliness and degree by which they are able to reduce the size and weight of today's fleets, and incorporate more fuel efficient power plants, drivelines, safety, and emission control devices. By monitoring the development and introduction of lightweight materials for use in automotive components, a better understanding of the weight reduction benefits through material substitution and parts redesign is obtained. The results of this analysis are presented as summary and detailed tabulations and figures for each manufacturer and for each of fourteen material and fourteen component areas. They address: material characteristics; component and part design and applications; technological advances in manufacturing processes; time frame for mass production; and the expected weight loss.

Volume III contains the results of one of four major areas investigated under the Automotive Manufacturing Assessment System (AMAS) which was designed to evaluate the capability of the automotive industry to produce fuel efficient cars and light trucks, and to assess the impact such conversion will have on producers and consumers. The other three areas are: Master Product Schedules (Volume I); Product Schedules of Engine/Driveline Combinations (Volume II); and Engine Manufacturing Analysis (Volume IV).

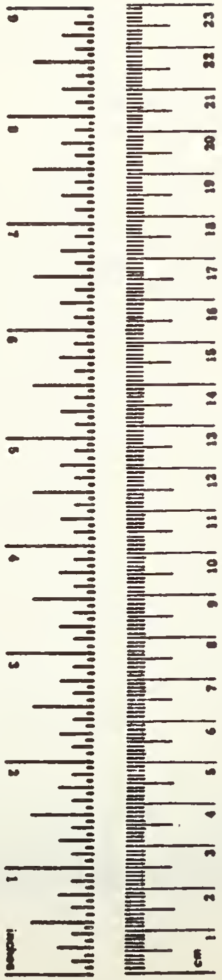
This volume is divided into six sections plus appendices. Section One presents the methodology used to track and analyze material weight changes for each manufacturer and for each material and component undergoing alterations, the results of which are presented in Section 3 (General Trends in Weight Reduction, for Each Manufacturer), Section 4 (Materials), and Section 5 (Components). As an aid in using this information, illustrative examples are contained in Section 2. Vehicle weight change schedules by market class for each manufacturer developed from publicly available information are included in Section 6. Supporting worksheets and reference sources are located in the appendices.

Corporate-Tech Planning wishes to acknowledge the guidance and assistance provided by Mr. George E. Byron, Transportation Industry Analysis Branch at TSC, who was the Technical Monitor for this program.

METRIC CONVERSION FACTORS

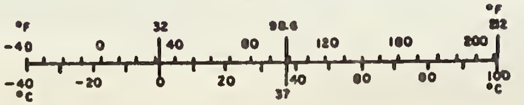
Approximate Conversions to Metric Measures

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



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LIST OF ABBREVIATIONS

ABS	Acrylonitrite Butadienestyreno
A/C	Air Conditioner
AD	Adhesives
ADB	Advanced Design Bus
AE	Automotive Engineering
AI	Automotive Industries
AL	(Alum.) Aluminum
AMC	American Motors Corporation
AMM/MN	(AMM) American Metal Market Metalworking News Edition
AN	Automotive News
B-O-P	Buick-Oldsmobile-Pontiac
BP	Major Body Parts
BR	Brakes
BU	Bumpers
BW	Business Week

LIST OF ABBREVIATIONS (CONTINUED)

C	Chrysler
CA	Catalysts
CD	Control Devices
CE	Ceramics
CID	Cubic Inch Displacement
CO	Carbon Monoxide
CR	Chrome
CR	Consumer Reports (in reference column)
CRIS	Computer Recall Identification System
CTP	Corporate-Tech Planning Inc.
CU	Copper
c.w.	Curb Weight
DD	Dunlop Denovo
DFP	Detroit Free Press
DOT	Department of Transportation
ED	Engine/Drivetrain Parts
EEC	Electronic Engine Control
EGR	Electronic Gas Recirculation
EL	Elastomers
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ES	Electrical Systems
F	Ford Motor Company
FA	Fasteners
FE	Iron
FIOD	Ford Integral Overdrive
FRP	Fiber Reinforced Plastic
FU	Fuels
FWD	Front-Wheel Drive
GE	General Mix Materials (in Materials Section)
GE	General Information (in Components Section)
GM	General Motors Corporation

LIST OF ABBREVIATIONS (CONTINUED)

HC	Hydrocarbons
H.D.	Heavy Duty
HDPE	High Density Polyethylene
HSLA	High Strength Low Alloy
HSS	High Strength Steel
ILZRO	International Lead Zinc Research Organization
IRS	Internal Revenue Service
KW	Kilowatt
LU	Lubricants
MCRB	Materials and Components Reference Book
MFG	(mfg) Manufacturer
MG	Magnesium
MI	Miscellaneous Components
MPG	(mpg) Miles per Gallon
MPH	(mpg) Miles per Hour
MT	Motor Trend
MVSS	Motor Vehicle Safety Standards
MY	Model Year
N	(n) New
NHTSA	National Highway Traffic Safety Administration
NO_x	Oxides of Nitrogen
O	(o) Old
OE	Original Equipment
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administration
PA	Paint (in Materials Section)
PA	Power Accessories (in Components Section)
PAN	Polyacrylonitrile
PBT	Polybutylene Terephthalate
pdn	Production
PGMs	Polygel Mitigation Energy Absorbers
PM	(P/M) (p/m) Powder Metal(s) (Metallurgy)
PPS	Polyphenenylene Sulfide
PROCO	Programmed Combustion

LIST OF ABBREVIATIONS (CONTINUED)

PS	Popular Science
PV	Pickup, Van and 4WD
RIM	Reaction Injection Molding
RO	Roofs
ROI	Return on Investment
R&T	Road & Track
SA	Scientific American
SAE	Society of Automotive Engineers
SC	Scrap
SE	Seats
SMC	Sheet Molding Compound
SS	Suspension and Steering
ST	Steel
T	Time
TI	Tires
TMT	Thermomechanical Treatment
TSC	Transportation Systems Center
VW	Volkswagen
WAR	Ward's Automotive Reports
WAW	Ward's Auto World
WEU	Ward's Engine Update
WH	Wheels
WSJ	Wall Street Journal
ZN	(Zn) Zinc

1. INTRODUCTION

Advances in material substitution and component redesign offer auto manufacturers increased opportunities for vehicle weight reduction, which is a major factor towards achieving 1985 fuel economy goals. Technological achievements allow manufacturers to substitute new lightweight materials for conventional steel and to redesign a component such that it requires less material or can be reduced in size while remaining functionally equivalent. Auto manufacturers and their suppliers undertake extensive development programs in seeking new applications for lightweight materials and in developing the processes by which the components can be manufactured, within the technical and economic limitations of the company.

By tracking and analyzing these developments as they are reported in the literature, an overall assessment can be made of the progress of weight reduction through material substitution and component redesign. Two tasks were performed based on synthesized information from literature research:

1. An abstraction and summarization of material-weight changes for each manufacturer for each material and component undergoing alterations.
2. Projection of vehicle weights by market class to 1985 for each manufacturer based on weights reported in the media.

Section 3, Section 4, Section 5 and Appendices A and B present the results of the effort described for Task 1 and collectively comprise a valuable research tool for identifying the auto manufacturers' current and future weight reduction strategies.

Summary tables which highlight material and component advances for each manufacturer are embodied in Section 3, General Trends in Weight Reduction. For each manufacturer, tables were generated emphasizing manufacturing processes (Tables 3-1, 3-3, 3-5), innovations in components (Tables 3-2, 3-4, 3-6, 3-9), and materials usage (Tables 3-7, 3-8). Worksheets for each manufacturer which contain abstracts of particular sources with the references relating to general trends in weight reductions are also included in Section 3.

Section 4, Materials, is comprised of summary tables for each of 14 materials featuring innovations and research in the areas of material processes, available alloys, and component applications, as well as suppliers researching further applications. These summary tables were derived from detailed worksheets (contained in Appendix A) for each material.

The summary sheets contained in Section 5, Components, present an overview of technological improvements for each of 14 component areas through the consolidation of information found on the component worksheets in Appendix B. Two types of summary sheets are featured:

1. Summary Tables (Tables 5-1 through 5-10) accentuate chronological developments in the application of particular component areas; and
2. Summary Figures (Figures 5-1 through 5-13) merge technological, manufacturing and other information concerning specific component types within the component area (i.e., hoods and deck lids within Major Body Parts subsection) compiled from worksheet abstracts in Appendix B.

Section 2, User's Guide, introduces and provides detailed instructions for utilizing the materials presented in Sections 3, 4, 5, and Appendices A and B of this volume.

The outcome of Task 2 is contained in Section 6, Vehicle Weight Change Schedules, and Appendix C of this volume. Section 6 incorporates the Vehicle Weight Change Schedules for each domestic manufacturer (Figures 6-1 through 6-4), plus all the supporting documentation regarding weight savings expected through component modification. In Section 6.2, Tables 6-2 through 6-5, "Announced Component Changes with Corresponding Weight Savings," enumerate for each manufacturer by market class the weight savings (or gain) realized by altering particular components. In Section 6.4, Figures 6-5 through 6-18, "Component Weight Changes," concisely identify changes for each component as reported in the literature. Appendix C, Component Inventory by Model, contains two types of matrices for each manufacturer's market class from which the user can find all sources referring to the use of a particular component in at least one model in that market class.

The information in Section 6 also cites the limitations of media research and suggests analysis of other areas, such as manufacturer product plans, for obtaining more complete projections of vehicle weights through 1985.

2. USER'S GUIDE

2.1 INTRODUCTION

The Materials and Components Reference Book (MCRB) (Sections 3, 4, and 5 and Appendices A and B of this volume) is a research tool designed to aid the researcher in analyzing the auto manufacturer's current and future weight reduction strategies and practices as reported in the media. As such, it provides a method for quickly sourcing specific information in the following categories:

- Material
- Component
- Auto Manufacturer
- Models
- Weight Savings
- Supplier
- Costs
- Tooling/Mfg. Processes
- Fuel Economy
- Reference Source.

In addition, the MCRB contains a variety of tables which provide a concise, well-organized vehicle for quickly: 1) reviewing events and trend predictions as reported in the industry publications and 2) examining recent advances in technology and production methods for components and new materials.

Information presented in this book was published in the media (See Table 2-1) between January 1, 1977 and October 1, 1977,* and emphasizes current events rather than historical practices of auto manufacturers. Thus, traditional methods and materials used by the auto industry are generally mentioned only in passing or to clarify a point. Emphasis is placed on changes made in materials, component design and manufacturing processes, thus allowing the researcher to explore a manufacturer's progress in his weight reduction effort.

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*This period covers MY '77 and MY '78 vehicles in substantial detail. Proposed future plans and some historical data are also included.

TABLE 2-1. MEDIA SOURCES

ABBREVIATION	
AMM/MN	American Metal Market Metalworking News Edition
AE	Automotive Engineering
AI	Automotive Industries
AN	Automotive News
BW	Business Week
CR	Consumer Reports
DFP	Detroit Free Press
MT	Motor Trend
PV	Pickup, Van and 4WD
PS	Popular Science
R&T	Road and Track
SA	Scientific American
T	Time
WSJ	Wall Street Journal
WAR	Ward's Automotive Reports
WAW	Ward's Auto World
WEU	Ward's Engine Update

2.2 ORGANIZATION

2.2.1 Major Sections

The major sections of the MCRB are described below:

Section 3 of this Volume, General Trends in Weight Reduction is arranged by manufacturer and highlights each manufacturer's activities regarding redesigned and lightweight components, new materials, and manufacturing processes. It is useful in analyzing each manufacturer's strategy for reducing the weight of his cars and light trucks and in reviewing his progress and proposed future plans regarding weight reduction.

Information presented in this section is derived from data found in Sections 4 and 5 and Appendices A and B of this volume. The specific reference source in which the information is located is found by tracing through the appropriate subsection of this volume as described in Section 2.5.2.

Section 4, Materials, is organized by type of material. Auto manufacturers and component suppliers are noted. Emphasis is placed on new, lightweight materials and the development of manufacturing processes which allow the large-scale use of these materials in autos. Thus, this section is useful in evaluating the degree to which these lightweight materials can be used in autos, light trucks and vans.

Although most articles in the literature mention both the component name and material used, articles have been classified according to their major emphasis, i.e., either the material used or the component design, in order to minimize overlap between the sections. Thus, for a researcher to acquire all the data concerning a particular material, he should also scan the worksheets in the related component figure of Appendix B.

Section 5, Components, is organized by component or component group. It emphasizes alterations made in both the design of the component and in the materials used. Benefits derived from the changes and models which contain the altered components are also noted. Thus, this section is useful for such tasks as: 1) describing the various techniques used to reduce the weight of a given component; 2) preparing an inventory of the models which employ each technique; etc.

As previously mentioned, a literature source which mentions both component name and material used has been assigned to Section 4 or Section 5 according to its major emphasis. Therefore, in order to acquire additional information concerning particular components a researcher should also scan any related material sections.

2.2.2 Subsections

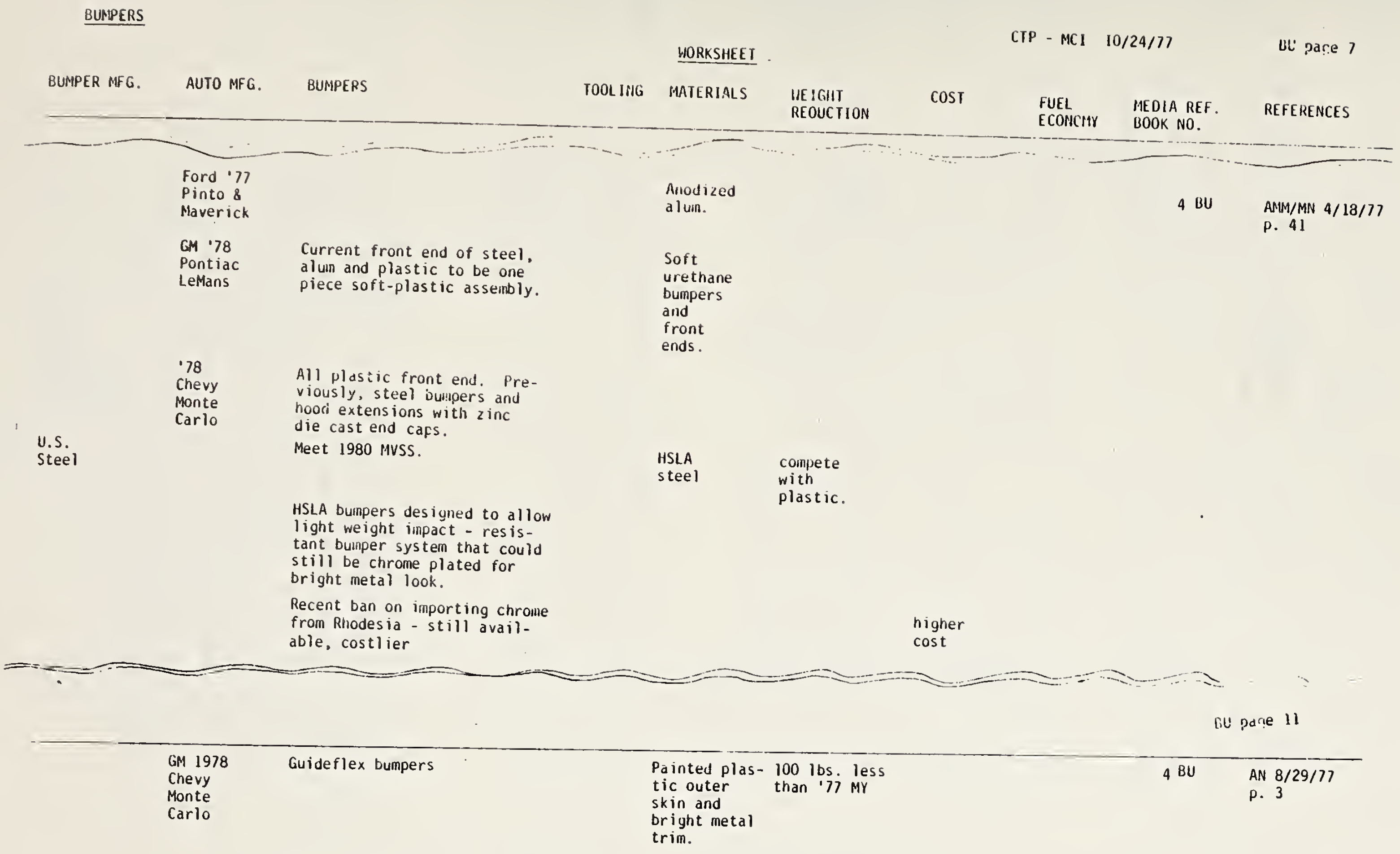
Each subsection is organized as an independent reference unit and should be considered the basic source of information on a particular subject area, e.g., auto manufacturer, material or component. Each contains an introduction, various summary tables and worksheets (Material and Component Worksheets are located in Appendices A and B respectively).

The introduction defines the area covered by the subsection, describes the worksheets and lists the summary tables included in the subsection. Worksheets and summary tables are described below in detail.

2.3 WORKSHEETS

The worksheet, the basic element of the MCRB, contains abstracts of articles pertaining to the given subject area. The unique abstracting method used provides the researcher with flexibility and facility in locating data so crucial to research in a multi-dimensional subject area.

Worksheets are organized with columns for specific data, such as component, material, auto manufacturer, supplier, processes, models, weight saved, miscellaneous notes and explanations and reference sources. Data found in an article is arranged horizontally, across the page (see Figure 2-1) under the appropriate column headings. Not all columns are filled for each abstract,



BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BU page 7

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
	Ford '77 Pinto & Maverick			Anodized alum.				4 BU	AMM/MN 4/18/77 p. 41
	GM '78 Pontiac LeMans	Current front end of steel, alum and plastic to be one piece soft-plastic assembly.		Soft urethane bumpers and front ends.					
	'78 Chevy Monte Carlo	All plastic front end. Previously, steel bumpers and hood extensions with zinc die cast end caps. Meet 1980 MVSS.							
U.S. Steel		HSLA bumpers designed to allow light weight impact - resistant bumper system that could still be chrome plated for bright metal look.		HSLA steel	compete with plastic.				
		Recent ban on importing chrome from Rhodesia - still available, costlier				higher cost			

BU page 11

	GM 1978 Chevy Monte Carlo	Guideflex bumpers		Painted plastic outer skin and bright metal trim.	100 lbs. less than '77 MY			4 BU	AN 8/29/77 p. 3

FIGURE 2-1. WORKSHEET ENTRIES

since the actual data reported varies between articles. However, by utilizing the worksheets such "data holes" can be identified and needed information can be sourced.

The first step in using the worksheet is to scan down a worksheet column and flag information reported directly. Additional information may be reported on the topic but have a "data hole" in the column scanned. In order to locate this information, another related column should be scanned on the same worksheets.

Because of the problem which data holes present, abstracts from the component worksheets (Appendix B) have been consolidated according to design type into "Summary Sheets" (Section 5). These sheets minimize data omissions limiting them to areas to be filled with information from other subsections (Figure 2-2).

Worksheet column headings differ between subsections. This is due in part to the fact that information reported in the media differs between subjects. The subsection introduction describes that sections' worksheet columns.

2.4 SUMMARY TABLES

Various tables which summarize the current state of technology and the application of that technology by the automotive industry have been derived from the worksheets via scanning particular columns and summarizing the data. Each of these summary tables adds a different perspective to an overview of developments reported in the media.

These tables currently found in the MCRB provide an overview of manufacturing processes, new alloys, actual and planned uses of new components and/or new materials and technology developments. Additional tables can be generated to expand this overview. For example, tables can be prepared to illustrate: 1) the relationships between supplier, manufacturer, and component; 2) components used in each model; 3) actual weight savings accomplished by material substitution or component redesign, etc.

BUMPERS

SUMMARY SHEET

CTP - MCI 11/10/77

BU page 5

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Soft-painted plastic with aluminum reinforced bar, metal trim		Guide-flex bumpers front and rear.		GM	'78 Chevy Monte Carlo '78 Grand Am	100 lb. less than Monte Carlo			4 BU	AN 8/29/77 p. 3 AMM/MN 4/18/77 p. 41

FIGURE 2-2. SUMMARY SHEET ENTRIES

2.4.1 Location of Summary Tables

The Tables found in Section 3 draw on information found in Sections 4 and 5 and Appendices A and B highlighting major innovations made in components and new manufacturing processes developed by each of the major manufacturers.

Tables in Section 4 (Materials) emphasize new materials and processes developed and those in Section 5 (Components) stress component design alterations (including materials used) and implementation of changes.

2.4.2 Types of Summary Tables

Each component subsection (5.1 to 5.14 contains a table entitled "Summary Sheet," which consolidates the information found in the worksheets (Appendix B) and presents an overview of events according to component or the design technique used. These tables look similar to worksheets and may be used in lieu of the worksheets. They are the only summary tables which include original reference sources.

Other summary tables, e.g., Materials in the Plastic Industry, Steel Processes in the Automotive Industry, Steel Components in Automobiles, etc. capsulize the most important information found in a subsection and do not mention original reference sources. More detailed information as well as original sources may be found by scanning appropriate columns of the subsection Worksheets or "Summary Sheet."

2.5 USING THE MCRB

The MCRB can be used in two ways: 1) to scan many reference sources in order to find specific data; and 2) to acquire an overview of events as reported in the media.

2.5.1 Scanning Many Reference Sources in Order to Find Specific Data

Locating specific data requires scanning the worksheets. In order to do this comprehensively, more than one subsection and a few different columns may be involved. The following steps outline a systematic method for locating data:

1. Select the most appropriate subsection.
2. Select the most appropriate Worksheet Column Heading(s).
3. Scan column(s).
4. Review data found. Does information reported suggest cross-referencing in another subsection? Scanning a different column?
5. If another subsection is suggested, begin again with Step 1.

The following example illustrates the use of the comprehensive data search method.

The three major aluminum suppliers (Alcoa, Kelsey-Hayes, and Reynolds) are deeply involved in developing new, stronger alloys, redesigning components to use the lightweight metals, and selling aluminum as a weight-saving substitute for iron and steel. In order to determine which components and processes Alcoa is specifically working on, the systematic method described above is used. The iterative process is outlined in Figure 2-3 and detailed below:

First Pass:

1) Select the most appropriate subsection: Figure A-3, Aluminum;

2) Select the most appropriate worksheet column: Supplier.

3) Scan the supplier column: This procedure flags the three abstracts found in Figure 2-4.

4) Reveiw data found: The abstracts indicate that Alcoa has been supplying aluminum hoods to GM and bumpers to both Ford and GM. In addition, Alcoa expects sales of aluminum wheels and bumpers to increase.

5) Is another column or subsection suggested: This data is very sketchy and leaves many questions unanswered, e.g., Is Alcoa currently selling aluminum wheels? Does Alcoa seel to Ford or Chrysler? Are these the only components Alcoa is working on? These data "holes" suggest looking into other subsections, specifically wheels, bumpers, body parts.

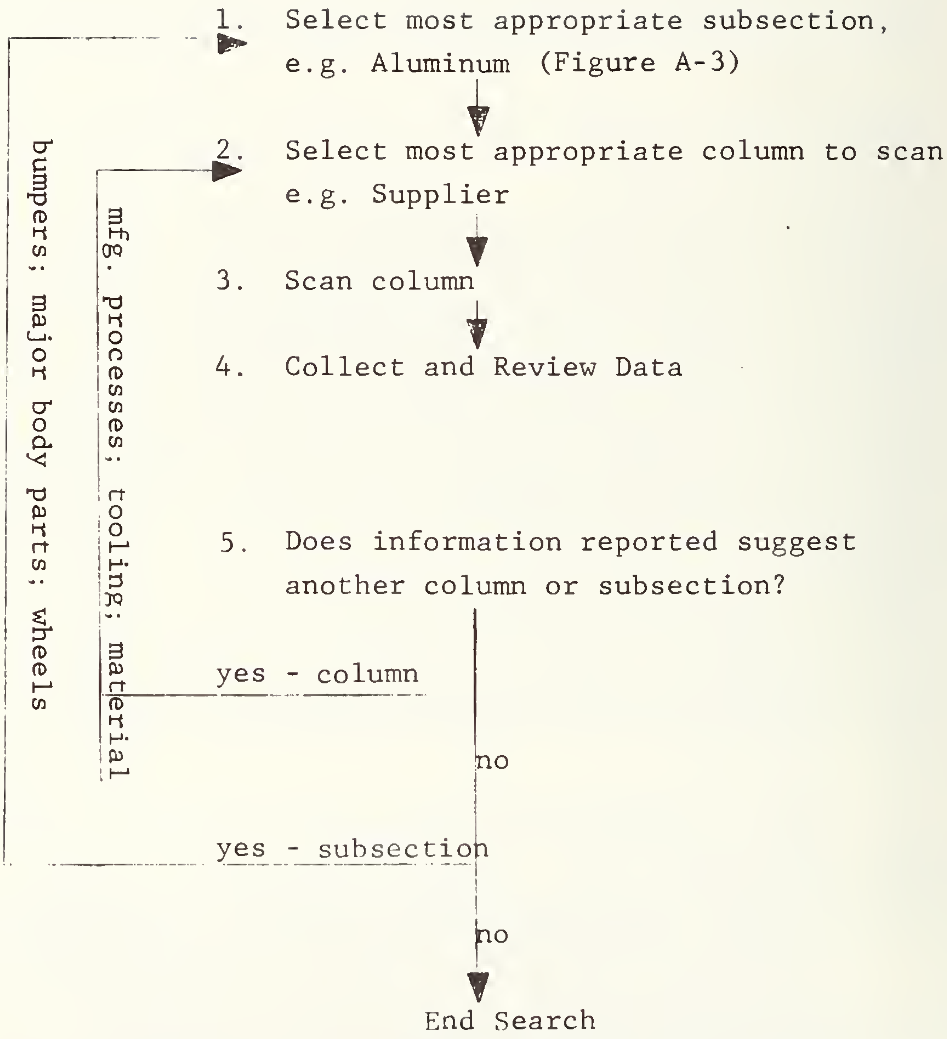
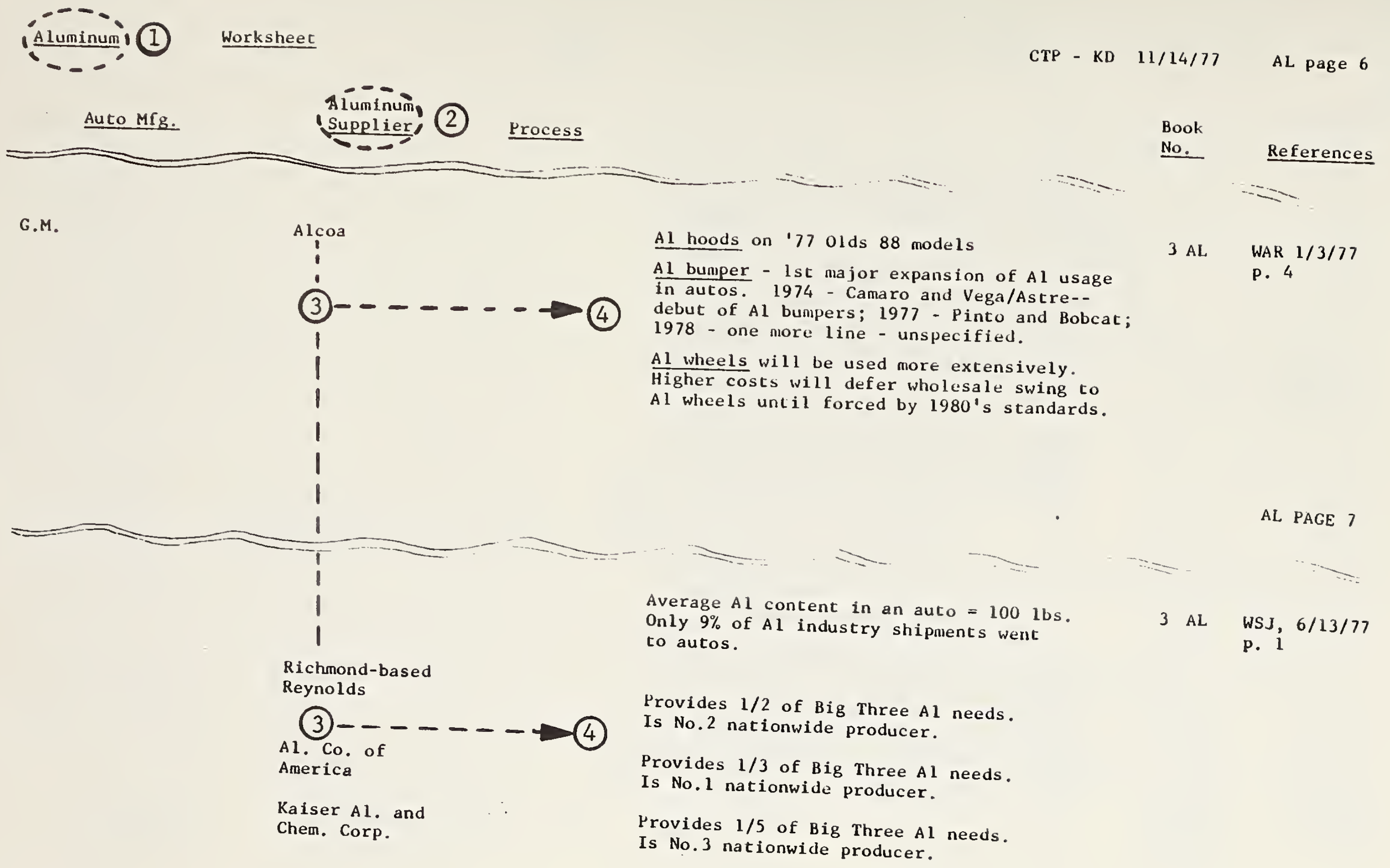


FIGURE 2-3. COMPREHENSIVE SEARCH METHODOLOGY



Aluminum ① Worksheet CTP - KD 11/14/77 AL page 6

Auto Mfg.	Aluminum Supplier ②	Process	Book No.	References
G.M.	Alcoa ③	④ Al hoods on '77 Olds 88 models Al bumper - 1st major expansion of Al usage in autos. 1974 - Camaro and Vega/Astre--debut of Al bumpers; 1977 - Pinto and Bobcat; 1978 - one more line - unspecified. Al wheels will be used more extensively. Higher costs will defer wholesale swing to Al wheels until forced by 1980's standards.	3 AL	WAR 1/3/77 p. 4

AL PAGE 7

		Average Al content in an auto = 100 lbs. Only 9% of Al industry shipments went to autos.	3 AL	WSJ, 6/13/77 p. 1
	Richmond-based Reynolds ③	④ Provides 1/2 of Big Three Al needs. Is No.2 nationwide producer.		
	Al. Co. of America	Provides 1/3 of Big Three Al needs. Is No.1 nationwide producer.		
	Kaiser Al. and Chem. Corp.	Provides 1/5 of Big Three Al needs. Is No.3 nationwide producer.		

FIGURE 2-4. WORKSHEET ABSTRACTS - PASS 1

Auto Mfg.	Aluminum Supplier ②	Process		Book No.	References
	③ Alcoa		④ Alloys 6009 and 6010 will replace 2036-T4 and 5182-0. 2036-T4 and 5182-0 inner/outer panel combination are not compatible for scrap. 6009 and 6010 are compatible. At T-6 temper,(i.e. after a paint bake cycle of 30 min. at 400°F) yield strengths are above most body sheet steels. At T-4 temper - good formability. Can produce commercial quantities of 6009/6010 next spring.	3 AL	WAW 12/76 p. 71
G.M.	Alcoa		Working on the all Al hood.		
	③ Alcoa	661	④ 2-7046 experimental alloy - for bumpers - 661 process: pre-treatment of chronium plated Al bumpers (non cyanide method) offered royalty free to encourage switches to Al bumpers.		
			6009-T4 and 6010-T4 for body sheet applications. Provide optimum combination of strength and formability in the "as received" T-4 condition with the ability to increase in strength considerably after a paint bake treatment. Advantages: (1) Excellent formability; (2) higher strengths after baking; (3) Improve corrosion resistance, spot weldability and surface appearance while maintaining equal finishing characteristics; (4) Promise of replacing steel parts with substantial cost savings due to high scrap value and lighter guage.	3 AL	AE 5/77 p. 48

FIGURE 2-4. WORKSHEET ABSTRACTS - PASS 1 (Concluded)

Second Pass:

1) Choice of subsections: bumpers (5.2); body parts (5.7); wheels (5.14) (Worksheets in Appendix B);

2) Choice of worksheet column: Supplier;

3) Scan supplier columns. No additional data is located for bumpers. Four more abstracts on wheels provide details on Alcoa's fabricated and forged aluminum wheels (Figure 2-5).

   Three articles on hoods (found in the Summary Sheet, Section 5.7) report on Alcoa as supplier of GM's '77 Olds 88 and '78 Buick Regal aluminum hoods. (Figure 2-6);

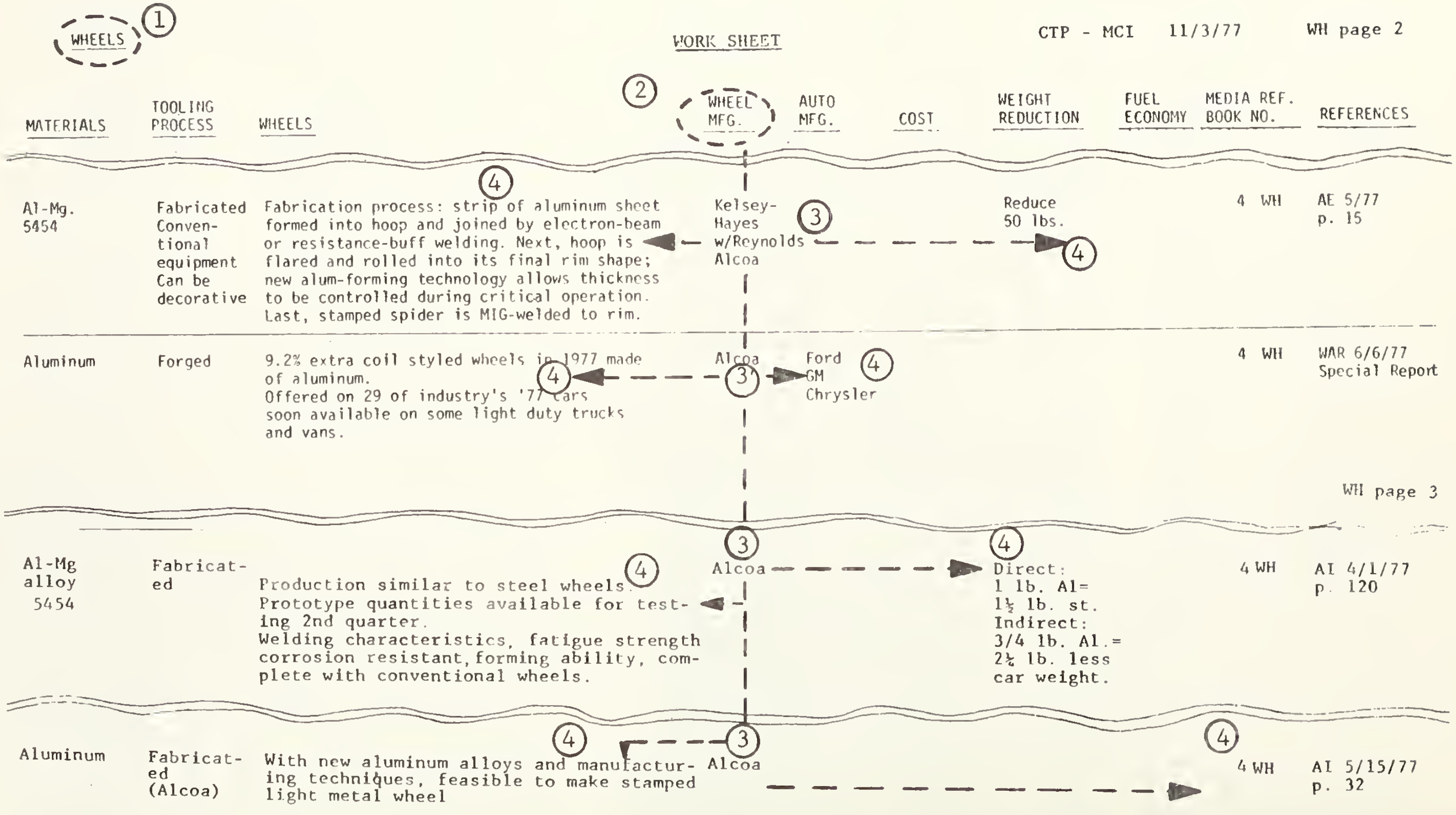
4) Review of data. In reviewing all the data gathered, it is evident that Alcoa's new alloys are 6009 and 6010 for body applications; Z-7046 for bumpers; Al-Mg 5454 for wheels. Also is involved in developing the experimental process 661 for chrome plating aluminum.

5) Are other columns or subsections suggested? Since these materials and processes relate specifically to Alcoa they suggest further columns to be explored. Thus, the researcher should repeat his search through the aluminum, wheel, bumper, and body part (hood) sections, this time scanning the process/tooling column for 661 and the materials column for 6009, 6010, Al-Mg 5454 and Z-7046.

Third Pass:

On this pass, no additional information is found in the aluminum section. The Worksheet of the Bumper section indicates that Ford is working with Alcoa on developing and using the 661 process to chrome plate aluminum bumpers for a portion of the MY'79 Panther line (Figure 2-7). Under hoods (Figure 2-8), an additional reference is picked up regarding 6009 being used on MY'78 heavy duty truck cabs. Since these new pieces of information do not suggest further scans, the search is terminated.

The information gathered on Alcoa can be summarized in a number of ways, depending on the researcher's specific needs. An example of one method is found in Figure 2-9 and is suitable for addition to the MCRB as an additional summary table.



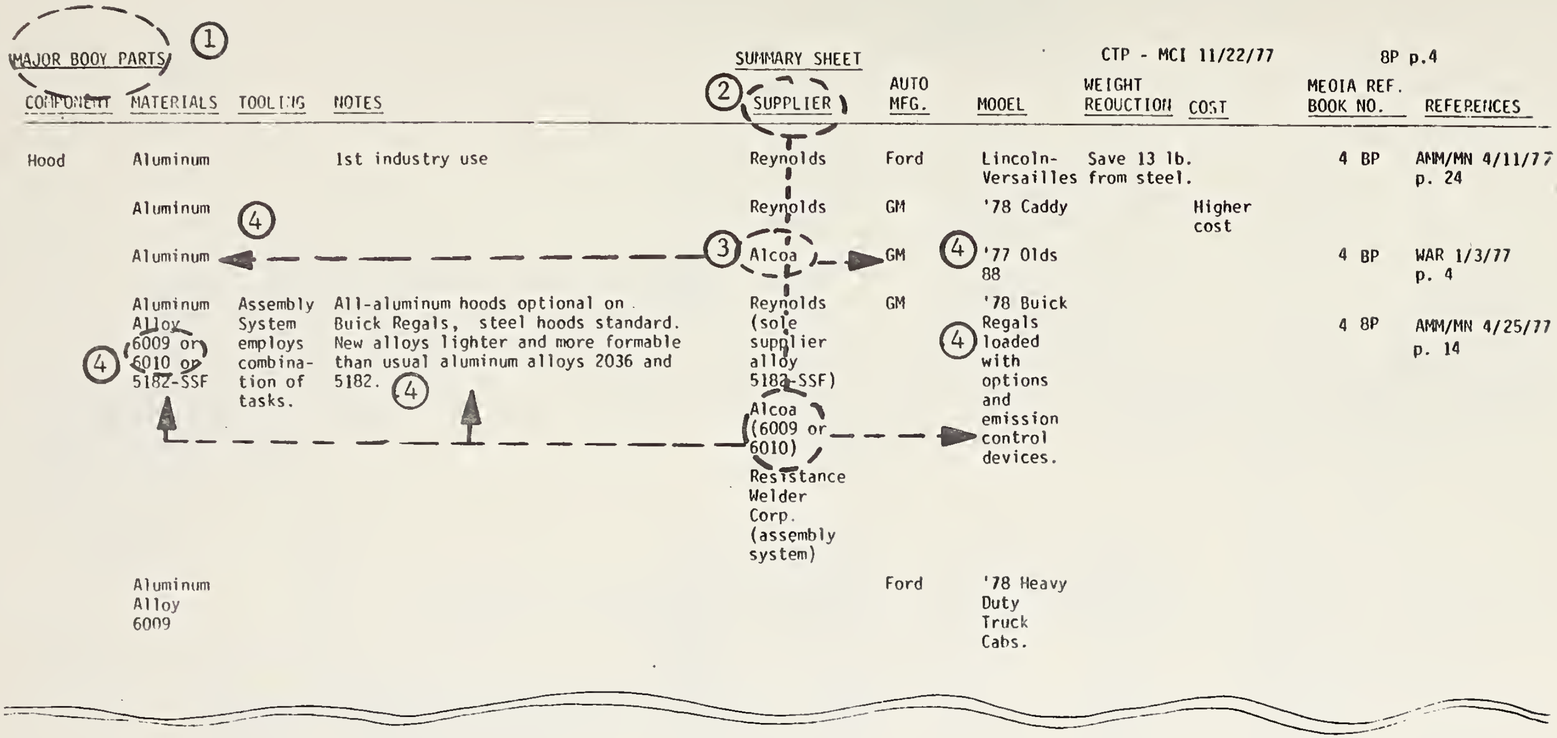
WHEELS   WORK SHEET   CTP - MCI   11/3/77   WH page 2

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Al-Mg. 5454	Fabricated Conventional equipment Can be decorative	Fabrication process: strip of aluminum sheet formed into hoop and joined by electron-beam or resistance-buff welding. Next, hoop is flared and rolled into its final rim shape; new alum-forming technology allows thickness to be controlled during critical operation. Last, stamped spider is MIG-welded to rim.	Kelsey-Hayes w/Reynolds Alcoa			Reduce 50 lbs.		4 WH	AE 5/77 p. 15
Aluminum	Forged	9.2% extra coil styled wheels in 1977 made of aluminum. Offered on 29 of industry's '77 cars soon available on some light duty trucks and vans.	Alcoa	Ford GM Chrysler				4 WH	WAR 6/6/77 Special Report

WH page 3

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Al-Mg alloy 5454	Fabricated	Production similar to steel wheels. Prototype quantities available for testing 2nd quarter. Welding characteristics, fatigue strength corrosion resistant, forming ability, complete with conventional wheels.	Alcoa			Direct: 1 lb. Al= 1½ lb. st. Indirect: 3/4 lb. Al.= 2¼ lb. less car weight.		4 WH	AI 4/1/77 p. 120
Aluminum	Fabricated (Alcoa)	With new aluminum alloys and manufacturing techniques, feasible to make stamped light metal wheel	Alcoa					4 WH	AI 5/15/77 p. 32

FIGURE 2-5. WORKSHEET ABSTRACTS - PASS 2



MAJOR BODY PARTS

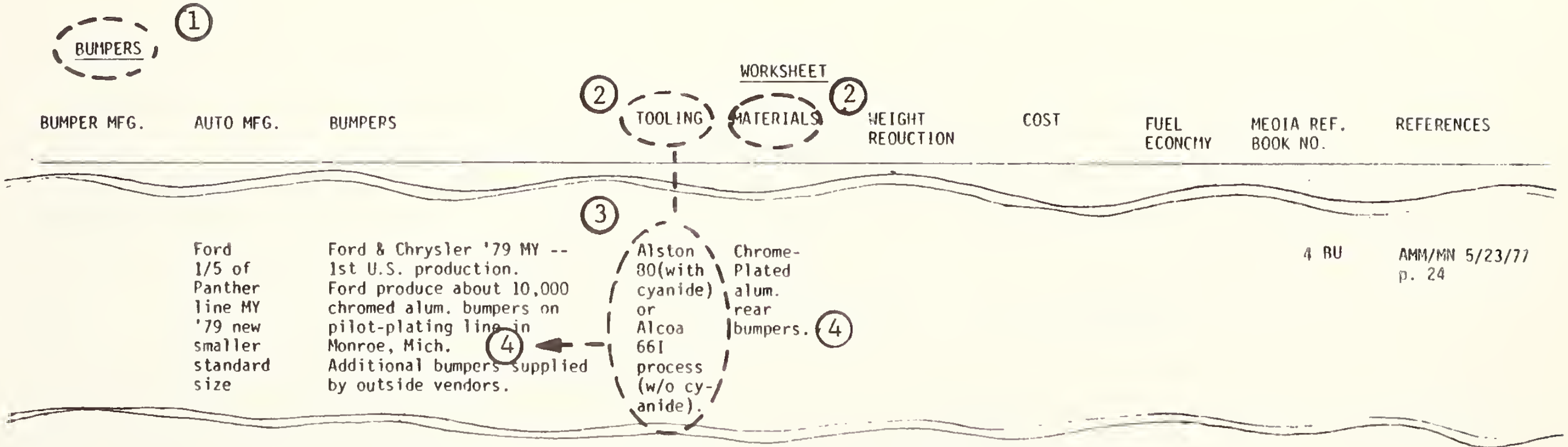
SUMMARY SHEET

CTP - MCI 11/22/77

8P p.4

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Hood	Aluminum		1st industry use	Reynolds	Ford	Lincoln-Versailles	Save 13 lb. from steel.		4 BP	AMM/MN 4/11/77 p. 24
	Aluminum			Reynolds	GM	'78 Caddy		Higher cost		
	Aluminum			Alcoa	GM	'77 Olds 88			4 BP	WAR 1/3/77 p. 4
	Aluminum Alloy 6009 or 6010 or 5182-SSF	Assembly System employs combination of tasks.	All-aluminum hoods optional on Buick Regals, steel hoods standard. New alloys lighter and more formable than usual aluminum alloys 2036 and 5182.	Reynolds (sole supplier alloy 5182-SSF) Alcoa (6009 or 6010) Resistance Welder Corp. (assembly system)	GM	'78 Buick Regals loaded with options and emission control devices.			4 8P	AMM/MN 4/25/77 p. 14
	Aluminum Alloy 6009				Ford	'78 Heavy Duty Truck Cabs.				

FIGURE 2-6. SUMMARY SHEET ABSTRACT - PASS 2

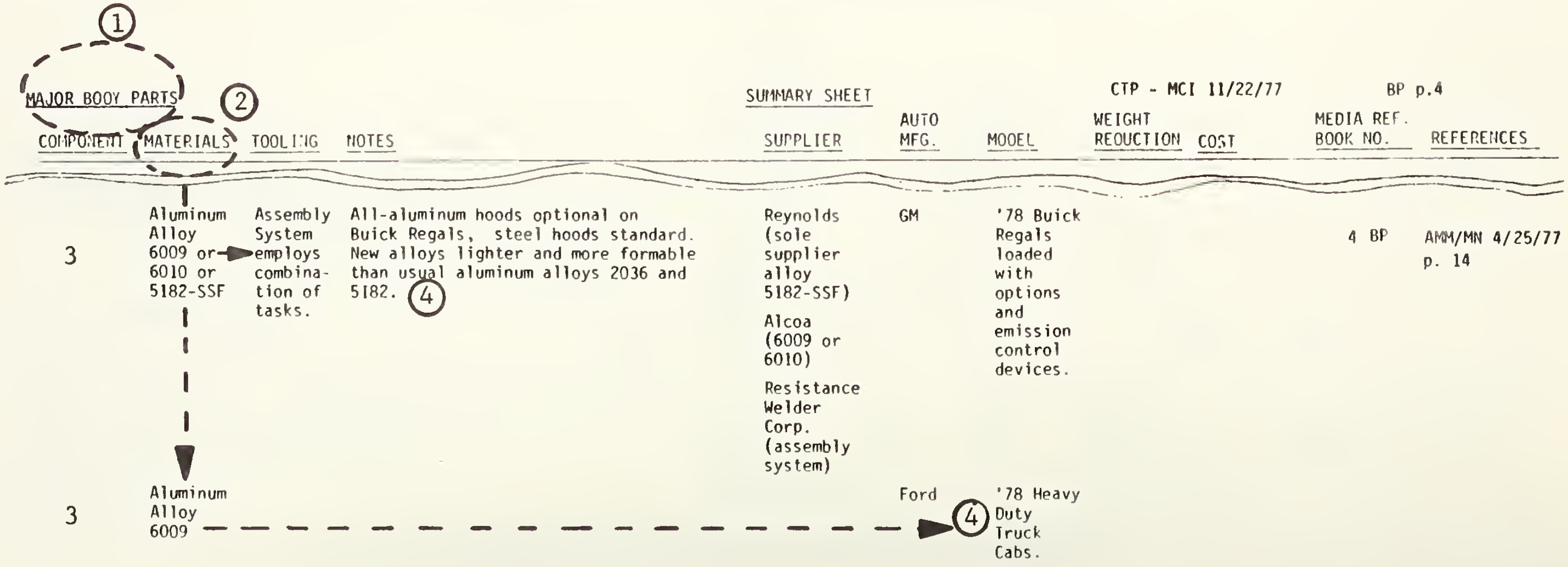


BUMPERS

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
	Ford 1/5 of Panther line MY '79 new smaller standard size	Ford & Chrysler '79 MY -- 1st U.S. production. Ford produce about 10,000 chromed alum. bumpers on pilot-plating line in Monroe, Mich. Additional bumpers supplied by outside vendors.	Alston 80(with cyanide) or Alcoa 661 process (w/o cyanide).	Chrome-Plated alum. rear bumpers.				4 BU	AMM/MN 5/23/77 p. 24

FIGURE 2-7. WORKSHEET ENTRIES - BUMPERS PASS 3



MAJOR BODY PARTS

SUMMARY SHEET

CTP - MCI 11/22/77

BP p.4

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
3	Aluminum Alloy 6009 or 6010 or 5182-SSF	Assembly System employs combination of tasks.	All-aluminum hoods optional on Buick Regals, steel hoods standard. New alloys lighter and more formable than usual aluminum alloys 2036 and 5182.	Reynolds (sole supplier alloy 5182-SSF) Alcoa (6009 or 6010) Resistance Welder Corp. (assembly system)	GM	'78 Buick Regals loaded with options and emission control devices.			4 BP	AMM/MN 4/25/77 p. 14
3	Aluminum Alloy 6009				Ford	'78 Heavy Duty Truck Cabs.				

FIGURE 2-8. SUMMARY SHEET ENTRIES MAJOR BODY PARTS: HOODS PASS 3

Alcoa

Number 1 Nationwide Aluminum Producer
Provides 1/3 of Big Three Aluminum Needs

hoods	compatible alloys 6009 and 6010	MY '77 Olds 88 MY '78 Buick Regal
bumpers	current production	Supplier to Ford, G.M.
	process 661 chrome-plating	Ford - 1/5 of MY '79 Panther Line
wheels	forged	Styled wheels on 29 MY '77 models Soon to be on light duty trucks and vans. Supplier to GM, Ford, Chrysler
	fabricated Al-Mg 5454 (with Kelsey-Hayes)	Available for testing in Spring '77.

FIGURE 2-9. SAMPLE, SUMMARIZED DATA

Although this example ends here, the researcher, of course, can terminate this investigation at any point depending on his actual needs. Additional passes can be made down the material, supplier, and tooling columns of all component subsections. Alternatively, the search could have been terminated earlier after the first or second pass.

2.5.2 Acquiring an Overview of Events Reported in the Media

The procedure for acquiring an overview of events is very straightforward since it merely entails reading the various summary tables on a given subject. Each of these tables provides a unique and different insight into the given subject area; as a collection, they present a broad overview of events regarding the given subject.

While reviewing the capsulized entries in the summary tables, the researcher may decide he needs additional details concerning a specific event. In such a situation, locating specific data and original reference sources in the worksheets is required and the five steps for locating specific data which are described in the previous section of this Guide (Section 2.5.1) should be followed.

This type of search is not as comprehensive as the Alcoa example since all data found in a summary table from Sections 4 and 5 can easily be located in worksheets pertaining to the same subsection by scanning the appropriate column(s). Other subsections need not be explored. For Section 3 (Auto Manufacturers) the subsection, in addition to the column, needs to be determined since this data is summarized from abstracts in both Sections 4 and 5 and could be from either section.

The following examples illustrate tracing summary table data to its original source.

<u>Example 1</u>

Section 3.3: Chrysler

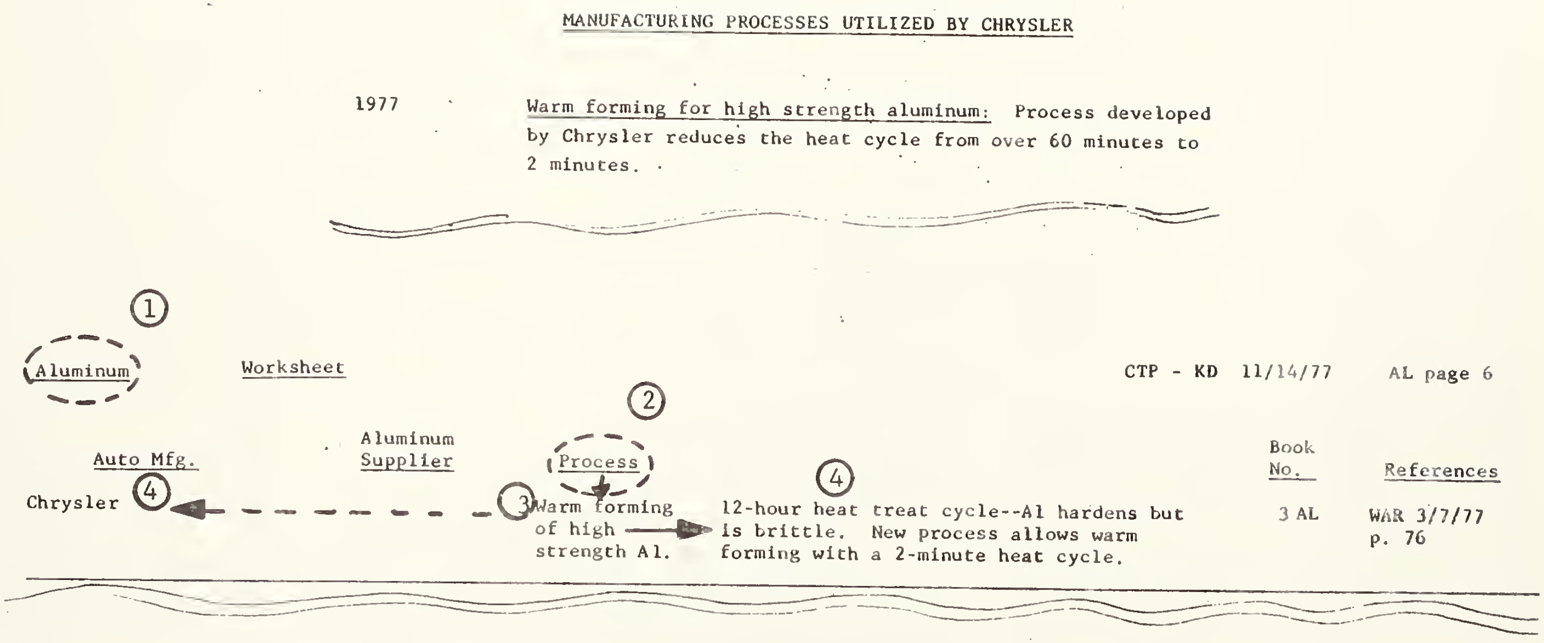
The first entry in the table "Manufacturing Processes Used by Chrysler," concerns a warm forming process developed by Chrysler (Figure 2-10). In order to verify this entry or to find more information on the process, scan the worksheet process column (Figure A-3) for the aluminum subsection. (Note: Since no components are mentioned, the subsection choice is straightforward.) The entry flagged is shown in Figure 2-11.

Example 2

Section 3.1: General Motors

The first entries in the table "Innovations in Components: General Motors Corporation," concern the use of aluminum brakes in G.M. autos (Figure 2-11). Three possibilities exist for tracing this data back to its original source: 1) Figure B-1 (Brakes) scan the material column for aluminum: 2) in Figure A-3 (Aluminum) scan either the auto manufacturer column for General Motors or the notes column for underlined component names; or 3) scan both the brakes and aluminum subsections.

The references flagged by scanning both subsections are shown in Figure 2-11 and include a reference source from each of the subsections. This, however, is not always the case, many searches will yield results in only one subsection.



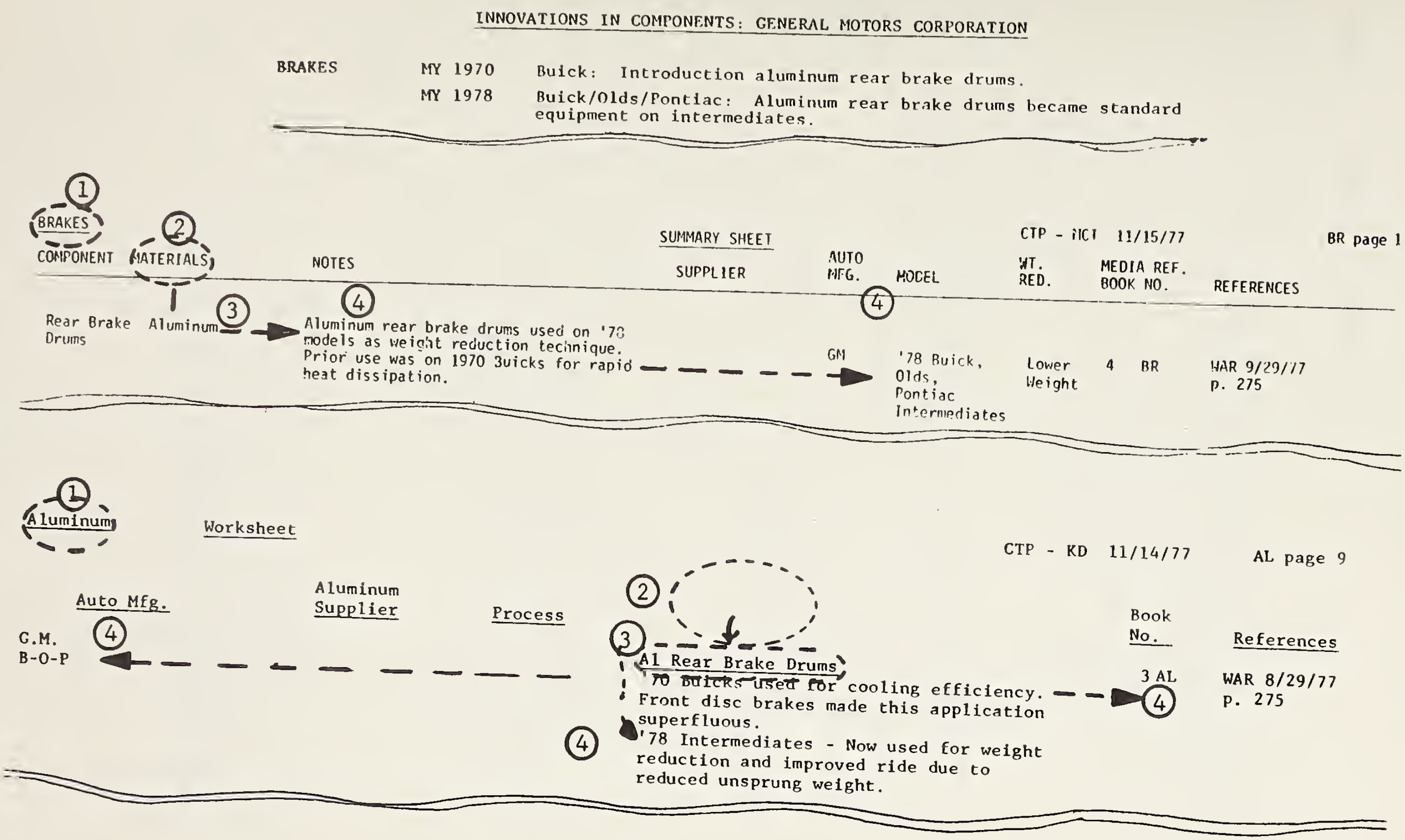
MANUFACTURING PROCESSES UTILIZED BY CHRYSLER

1977 Warm forming for high strength aluminum: Process developed by Chrysler reduces the heat cycle from over 60 minutes to 2 minutes.

Aluminum Worksheet CTP - KD 11/14/77 AL page 6

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Chrysler		Warm forming of high strength Al.	12-hour heat treat cycle--Al hardens but is brittle. New process allows warm forming with a 2-minute heat cycle.	3 AL	WAR 3/7/77 p. 76

FIGURE 2-10. SUMMARY TABLE WITH CORRESPONDING WORKSHEET ENTRY



INNOVATIONS IN COMPONENTS: GENERAL MOTORS CORPORATION

BRAKES	MY 1970	Buick: Introduction aluminum rear brake drums.
	MY 1978	Buick/Olds/Pontiac: Aluminum rear brake drums became standard equipment on intermediates.

BRAKES

SUMMARY SHEET

CTP - MCT 11/15/77

BR page 1

COMPONENT	MATERIALS	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT. RED.	MEDIA REF. BOOK NO.	REFERENCES
Rear Brake Drums	Aluminum	Aluminum rear brake drums used on '78 models as weight reduction technique. Prior use was on 1970 Buicks for rapid heat dissipation.		GM	'78 Buick, Olds, Pontiac Intermediates	Lower Weight	4 BR	WAR 9/29/77 p. 275

Aluminum

Worksheet

CTP - KD 11/14/77

AL page 9

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
G.M. B-O-P			Al Rear Brake Drums '70 Buicks used for cooling efficiency. Front disc brakes made this application superfluous. '78 Intermediates - Now used for weight reduction and improved ride due to reduced unsprung weight.	3 AL	WAR 8/29/77 p. 275

FIGURE 2-11. SUMMARY TABLE WITH CORRESPONDING WORKSHEET ENTRIES

3. GENERAL TRENDS IN WEIGHT REDUCTION

3.1 GENERAL MOTORS CORPORATION

3.1.1 Subject Area

This section includes information on General Motors Corporation's weight reduction strategy and its expectations of meeting the 1985 fuel economy goals. It presents an overall view of General Motor's progress and announced future plans for:

1) weight reduction via component re-design and material substitution,
2) materials usage,
3) manufacturing processes directly impacting on weight reduction potential.

The information found in this section is derived from two sources:

1) articles from Media Reference Book 2 and
2) the summaries found in sections 4 and 5 of this volume.

3.1.2 Indexing Method - Worksheets

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to weight reduction strategies: WEIGHT REDUCTION APPROACH, WEIGHT REDUCTION DETAILS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for information which is most relevant to his current needs. (See Figure 3-1.)

3.1.3 Summaries

The following tables included in this section present an overview of General Motors' weight reduction strategy:

TABLE 3-1. MANUFACTURING PROCESSES USED BY GENERAL MOTORS
TABLE 3-2. INNOVATIONS IN COMPONENTS: GENERAL MOTORS CORPORATION

TABLE 3-1. MANUFACTURING PROCESSES USED BY GENERAL MOTORS

MECHANICAL FASTENING	GM has developed a new system to attach mechanical fasteners to structural components. This method uses new electronic fastening tools which permit more precise measurement of the clamping force of each fastener.
METAL-TO-METAL BONDING SYSTEM	GM Fisher Body Division is researching adhesives for metal-to-metal bonding systems.
COMPRESSION MOLDING	GM produced first plastic full-length front header panels on 1978 MY Chevrolet intermediate cars. The panels are formed in one piece out of glass fiber-reinforced polyester on compression molding machines at Chevy's Flint, Michigan facilities. The panels are coated with a new polyurethane primer (developed by Sherwin-Williams) prior to assembly on the cars.
INJECTION MOLDING	GM manufactures injection molded plastic (ex-reinforced polypropylene copolymer) fender liners for some 1978 MY intermediate cars at its Adrian, Michigan plant.
IN MOLD PRIMERS	GM's Chevrolet Division is also working with General Tire and Rubber Company on the development of in-mold primers for compression molded plastic body parts. This process will be used first on MY '79 Corvette roofs. It permits the design of thinner plastic panels with built in strengthening sections and eliminates post mold priming time and some finishing expenses.
RIM	GM is developing a fender made from high modulus RIM (reaction injection molding) urethane which would return to its original shape after impact. In a joint program with chemical manufacturers, GM is studying the effect of glass fillers on both the properties of urethane polymer and RIM process. A glass filler in the urethane would improve the interface between the plastic fender and the sheet metal to which it attaches; however, the glass acts as an abrasive in the tooling and decreases the life of the equipment. A large scale production of fenders is expected in early 1980's.
CHROME SPUTTERING	The chrome-sputtering process used by GM's Chevrolet Division is a method of chrome plating soft and rigid (ABS) plastic components. It is a less expensive and more efficient alternative to electroplating plastic components. First production application was on 1977 MY Caprice lower grilles by GM's Guide Division in Anderson, Indiana. Additional applications and tests are planned for MY 1978 and later.

TAPLE 3-1. MANUFACTURING PROCESSES USED BY GENERAL MOTORS (Concluded)

VACUUM METALIZING	This process is used to coat plastic with aluminum and is being adapted for chrome plating, It is similar to chrome sputtering and is less expensive and more efficient than conventional electroplating. GM will be using this process,
LOW PRESSURE CASTING	Media reports purchase of low pressure casting equipment for MY 1978 aluminum auto components by Chevrolet Division. Low pressure casting is used overseas more extensively than in the U.S. Claims for its superiority over conventional casting include: 1) higher yields in the casting wt/metal poured ratio (low pressure casting yields = 90-95% or higher; 2) decrease in manufacturing energy consumption; 3) lower tooling costs. It is also a better casting method for large parts.
STAMPING	GM uses stamped HSLA steel impact beams in place of roll-formed impact beams in the doors of 1978 MY intermediates. The new beams are designed to take advantage of high-volume stamping rates and economies and increased formability of new HSLA steel.
PAINT APPLICATION	GM uses lacquers on all cars. This method can be a low energy user if paints are air-dried, rubbed and polished; however, General Motors uses a bake method which consumes more energy (1977). General Motors assembly plants in Los Angeles have switched to water-based enamels due to high atmospheric hydrocarbon levels attributable to lacquer solvents. This uses a high energy process which requires baking car bodies at 325°F and closely controlling humidity via air conditioning equipment. GM truck lines switch from alkyd enamels to acrylic enamels for increased corrosion-resistance (1977-78). GM uses Elpo, a rust-resistant cathodic electro-deposition resin primer (1977-78).
MANUFACTURE OF AIR INJECTION PUMPS	Saginaw Steering Gear Division of GM plans to tool up again for the mass production of air injection pumps, which are emission control devices. (Saginaw had tooled up in the early 1970's for air-pump production but catalytic converters developed in 1974 were sufficient to meet emissions standards then). This new tooling will be installed both at the Saginaw, Michigan plant and a new plant under construction in Limestone County, Alabama. Equipment needs include metal cutting transfer machines, assembly machines, drilling and deburring units, turning machines, grinders, extrusion, powder metal compacting and sintering equipment, and annealing and drawing furnaces for certain parts.

TABLE 3-2. INNOVATIONS IN COMPONENTS: GENERAL MOTORS CORPORATION

BRAKES	MY 1970	Buick: Introduction aluminum rear brake drums.
	MY 1978	Buick/Olds/Pontiac: Aluminum rear brake drums became standard equipment on intermediates.
BUMPERS	MY 1970	Pontiac: First industry use soft front and rear end.
	MY 1976	Chevrolet Monza: Experimental HSLA bumper met 1980 safety standards. (lighter than plastic bumper).
	MY 1978	Pontiac Lemans/Chevrolet Camaro: First industry use of one-piece all plastic front and rear ends.
CONTROL DEVICES	MY 1978	Cadillac Seville: Offered tripmaster, first true high-performance computer offered for sale in autos.
ELECTRICAL SYSTEMS	MY 1977	Used fiber optics in dashboard of some heavy duty trucks.
ENGINE/ DRIVETRAIN PARTS	MY 1970	Chevrolet: Introduction of Vega's all-aluminum engine (discontinued in 1977).
	Jan. 1977	First industry use of cast iron ring and pinion gears on rear axle of full-size station wagons (saved 2 lbs. per set).
	MY 1978	Olds: First diesel for passenger car by U.S. manufacturer offered as option.
	MY 1978	Buick: First in industry to offer even-firing V-6 turbocharger engine (option).
	MY 1979	Compacts: Plan to have front wheel drive.
FASTENERS	MY 1977	Use new electronic fastening tools to secure mechanical fasteners in a pilot program,
GRILLES	MY 1977	Chevrolet Caprice: First production application of chrom-sputtered ABS plastic lower grilles.
	MY 1979	Chevrolet: Plan to use chrome sputtered ABS plastic upper grilles.

TABLE 3-2. INNOVATIONS IN COMPONENTS: GENERAL MOTORS CORPORATION (Concluded)

MAJOR BODY PARTS	MY 1977	Olds, Cadillacs: First industry use of aluminum hoods (option).
	MY 1977	Standard size cars have galvanized HSLA steel floor pans, outer wheel house.
	MY 1978	Chevrolet/Buick: First industry use of aluminum deck lids (option).
	MY 1978	Chevrolet: Aluminum trunk lids offered.
	MY 1978	Stamped one-piece HSLA steel door beams replace roll-formed HSLA steel on intermediates.
	MY 1978	Chevrolet: First industry use one piece glass fiber-reinforced polyester front header panels coated with special polyurethane primer.
	MY 1978	Chevrolet Corvette: Rear end mountings made of glass fiber - reinforced sheet molding compounds.
SEATS	MY 1978	Chevrolet Corvette: First industry use of all-plastic seats.
TIRES	MY 1977	Standard size cars: Tire sizes F, G. H were reduced 2-2½ lbs. without affecting performance.
	MY 1978	Intermediates: Have high pressure (60 psi) compact spare tire which saves 11-14 lbs.
WHEELS	1960	Pontiac: Offered first cast aluminum wheel as an option.
	1977	Offered styled forged aluminum wheels.
TOTAL CAR	MY 1978	Redimensioned Intermediates resulted in weight reductions: 1. 150 lbs. Saved from 6-in. narrower and 17 in. shorter dimensions. 2. 152 lbs. Smaller engines, wheels, tires brakes. 3. 289 lbs. HSLA steel, aluminum, and plastics - off body. 4. 76 lbs. Bumpers. 5. 42 lbs. Steering and suspension components. 6. 44 lbs. Fuel and exhaust. 7. 82 lbs. Frame.

WORKSHEET

CTP - KD 11/8/77 GM p. 1

GENERAL TRENDS IN WEIGHT REDUCTION

GENERAL MOTORS		MEDIA REF. BOOK NO.	REFERENCES
HSS bumpers	Pontiac Sunbird	2-Misc.	WAW 9/77 p. 44
Galvanized Steel	Intermediates - Olds Cutlass - outer door panels outer quarter panels spare tire pocket and rocker panels	2-Misc.	WAW 9/77 p. 46
Weight Reduction	To meet 22.4 mpg in 1981 15% wt. reduction average in '77 inertia wts. 27.5 mpg in 1985 13% additional reduction	2-GM	WAR
Electric Auto	To be available in 1980's	2-GM	Boston Globe 6/19/77 p. E-1
THM 200 Automatic Transmission	Running change: metal to plastic in the governor cover. GE's VALOX resin 420 Requires no machining.	2-Misc.	WAW 4/77 p. 54
Olds Cutlass Supreme '78	700 lbs. wt. savings Al usage = 112 lbs. savings: Al hood 32 lbs. bumper reinforcements 37 lbs. Al rear brake drum 13 lbs. Al intake manifold V-8/260 30 lbs.		
1978 Intermediates	Use full frame construction because of rigidity, handling and quietness. Full frame is heavier than partial frame or unitized body. Company has reduced Intermediates by 550-980 lbs., or up to 23% of their 1977 counterparts.	2-GM	AMM/MN 7/27/77 p. 5

FIGURE 3-1. GENERAL MOTORS WORKSHEET

WORKSHEET

CTP - KD 11/8/77 GM o. 2

GENERAL TRENDS IN WEIGHT REDUCTION

GENERAL MOTORS

		MEDIA REF. BOOK NO.	REFERENCES	
Transmission	T-10 4 speed manual Cast Fe = 85 lbs. Al case = 70 lbs. (Corvette) 1977 differentials - G.M. introduced cast nodular iron ring & pinion gears - (1st in auto industry) replacing steel forgings in G.M. full & intermediate wagons w/8-3/4 in. rear axle 2.0 lb. savings.	2-Misc.	AI 7/1/77	p. 37
Intermediates Chevy Intermediates all but Pontiac	Plastic 1-piece header panel w/integral fender extensions, grille "surround" and hood extension in 1978. SMC and new in-mold priming technique. Glass-reinforced inner fender liners in 1978.	2-Misc.	WAW 9/77	p. 42
Chevy Monte Carlo	Front end panel (1-piece) saves 12 lbs. over stamped steel and die cast Zn multi-piece assembly.	2-Misc.	WAW 9/77	p. 42
Pontiac LeMans LeMans Grand Am	Resiliant plastic front & rear bumper systems: Rim facias w/soft chrome moldings; in combination w/other plastic components. Replace chrome plated steel bumpers - save 112 lbs. (including downsizing loss).	2-Misc.	WAW 9/77	p. 42
Camaro (Chevy) Monte Carlo	Soft face front and rear bumpers replace all-aluminum bumpers Soft bumper system replaces chrome-plated steel bumpers	2-Misc.	WAW 9/77	p. 43
Al deck lids	Chevy Monte Carlo Buick Regal	2-Misc.	WAW 9/77	p. 43
Al brake drums	(rear) Monte Carlo	2-Misc.	WAW 9/77	p. 43
Al hoods	'78 Intermediates Buick & Olds - compensate for wt. of emission control components and certain options, especially California options. Alloy 6010.	2-Misc.	WAW 9/77	p. 43
Al intake manifolds	'78 - 8/260 and 8/350 engines Chevy, Olds, Cadillac. Manifolds weigh 15-16 lbs. each.	2-Misc.	WAW 9/77	p. 44
Al bumper reinforcement bars	Most GM downsized intermediates	2-Misc.	WAW 9/77	p. 44
Pontiac Intermediates	1. Cast Al wheels 2. Stamped Al radiator supports 3. Al Master brake cylinders	2-Misc.	WAW 9/77	p. 44

FIGURE 3-1. GENERAL MOTORS WORKSHEET (Continued)

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

GENERAL MOTORS		MEDIA REF. BOOK NO.	REFERENCES	
Weight Reduction details	'78 Olds, 98 Regency - Saved 2½ lbs. using 1202 velour instead of 1602	2-GM	WAW 9/77	p. 59
Interior Fabrics	Formed-on seats molded trim of knit velour (Monte Carlo bench seat) Tooling required: costly - eventually price can be reduced. Design originality enhanced, backing strength increased; less material needed (wt. reduction). Will be used in '79.	2-GM	WAW 9/77	p. 59
Weight Reduction details - by model 1978	Monte Carlo 2 dr. coupe 803 lbs. lighter Malibu and Malibu Classic { 2 dr. coupe 540 lbs. lighter 4 dr. sedan 608 lbs. lighter Wagon 968 lbs. lighter El Camino 800 lbs. carrying capacity maintained by lengthening pick up box 7" LeMans 2 dr. 500 lbs. lighter Grand Safari Wagon 900 lbs. lighter Cutlass 657 lbs. lighter Buick Regal 560 lbs. lighter	2-GM 2-GM	WAR 9/19/77 AN 8/29/77	p. 300 p. 2
Intermediates - How weight reduced:	1. 150 lbs. saved from 6-in. narrower and 17 in. shorter dimensions 2. 152 lbs. smaller engines, wheels, tires, brakes 3. 289 lbs. HSLA steel, aluminum, and plastics - off body 4. 76 lbs. Bumpers 5. 42 lbs. Steering and suspension components 6. 44 lbs. fuel and exhaust 7. 82 lbs. frame	2-GM	WAR 9/12/77	p. 292
Cadillac	Wt. Reduction in 2 major areas. 1. Al intake manifold - Seville - 31 lbs. lighter 2. Al hood - most Broughams and all Calif. & EFI Sedan deVille models - 45 lbs. lighter	2-GM	AN 9/12/77	p. 19
Corvette	Lose 400 lbs. in '79-80 w/o major styling changes utilizing the following; Reduce fiberglass (350 lb.) by 15% Reduce steel gauge used Use molded plastic seat - 25 lb. saving Lighter bumper system Al or plastic wheels Plastic hood panel Composite doors	2-GM	AN 8/8/77	p. 3

FIGURE 3-1. GENERAL MOTORS WORKSHEET (Continued)

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

GENERAL MOTORS		MEDIA REF. BOOK NO.	REFERENCES
1978 Intermediates	Full frame construction - heavier than partial frame/unitized body.	2-GM	AMM/MN 7/25/77 p. 5
After 1982	May have to repeat shrinking process to meet 1985 standards.	2-GM	8.W. 5/23/77 p. 100
Al Hoods	Olds. 88, Toronado; Versailles.	2-GM	8.W. 5/23/77 p. 100
Trunk Lid (Al)	'78 Chevy Monte Carlo	2-GM	8.W. 5/23/77 p. 100
New V-6 Engine (Intermediates)	Light cast Fe unit; w/Al intake manifold weighing 13 lbs. each and smaller radiator 11.7 lbs. (rather than 13.5 lbs.)	2-GM	AMM/MN 8/8/77 p. 13
Intermediates Weight Reduction Program	1. Shorter frames and bodies 2. Smaller drive train components 3. Plastic front end panels 4. High strength steel door intrusion beams 5. HSS bumpers w/Al reinforcement bars (face bars) most wt. savings from reduction in sheet metal body and frame dimensions.	2-GM 2-GM 2-GM	AI 6/1/77 p. 29 AMM/MN 5/2/77 p. 14 WAW 9/77 p. 44
Malibu and Malibu Classics	550-1,000 lbs. lighter than in '77.	2-GM	AI 6/1/77 p. 29
V-8/350 2 bbl	Wt. loss 30-40 lbs. due to Al intake manifold Camaro Impala Caprice Classic	2-GM 2-GM	AI 6/1/77 p. 29 AN 8/29/77 p. 2
Alteration of Weight Ranges for Market Classes	1977 Ave.Wt. 1985 Ave.Wt. Inertia Wts.: Subcompact 3420 2690 MY 1981=3010 MY 1982=2690 Compacts 3870 2830 Intermediate 4490 3070 MY 1978=3570 MY 1984=3070 Large 4240 3550 MY 1978=4240 MY 1983=3560 Corvette 4000 2500	2-GM	AI 6/1/77 p. 29
V-8/305 → V-6/231 V8/301 → V-6/231	Monte Carlo Grand Prix	2-GM	AMM/MN 5/2/77 p. 14
1978 Intermediates	Almost 700 lbs. lighter (USNWR) approx. 800 lbs. lighter (MT 8/77, p. 13) 650 lbs. less (AMM/MN 9/19/77, p. 5)	2-GM	U.S.News & World Report 9/26/77 p. 29
Diesel Engines	2 diesel V-8's : Oldsmobile. Cadillac mid-year. $740 (cost penalty) } depends on which engine the diesel replaces. $850 (cost penalty) }	2-GM	U.S.News & World Report 9/26/77 p. 29

FIGURE 3-1. GENERAL MOTORS WORKSHEET (Concluded)

3.2 FORD

3.2.1 Subject Area

This section includes information on Ford Motor Company's weight reduction strategy and expectations of meeting the 1985 fuel economy goals. It presents an overall view of Ford's progress and announced future plans for:

1) weight reduction via component re-design and material substitution
2) materials usage
2) manufacturing processes directly impacting on weight reduction potential.

The information found in this section is compiled from two sources:

1) articles found in Media Reference Book 2 and
2) summaries found in sections 4 an 5 of this volume.

3.2.2 Indexing Method - Worksheets

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to weight reduction strategies: WEIGHT REDUCTION APPROACH, WEIGHT REDUCTION DETAILS, MEDIA REFERENCE BOOK NUMBER and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. (See Figure 3-2.)

3.2.3 Summaries

The following tables included in this section present an overview of Ford's weight reduction strategy:

TABLE 3-3. MANUFACTURING PROCESSES USED BY FORD
TABLE 3-4. INNOVATIONS IN COMPONENTS: FORD

TABLE 3-3. MANUFACTURING PROCESSES USED BY FORD

MY		
1977	APPLICATION OF PAINTS	Enamels and lacquers are generally used. Lacquers are applied via the air-dry rub and polish method which is a low energy process.
1978	THERMOPLASTIC STAMPING	The Maumee, Ohio plant converted metal stamping equipment to plastic forming applications in order to use a proprietary stamping process developed in 1976. This equipment was used for the manufacture of MY '78 fender liners for F Series Light Trucks. Eight hydraulic presses were ordered to provide additional capacity for the manufacture of fender liners for autos.
	LOW PRESSURE CASTING AND GRAVITY PERMANENT MOLD CASTING	These methods will be used to produce aluminum intake manifolds for the first time at Ford for MY 78 Granada and Monarchs.
1979	STAMPED STEEL	Planning production of stamped (rather than cast) steel rocker arms in Cleveland plant in 1979 or 1980.
	COLD EXTRUSION TECHNIQUES	These techniques replace hobbing, pot broaching and other chip-forming operations. Using these methods, Ford has developed a new technique for roughing out transmission helical gears. It uses less energy and less floor space, reduces overall tooling costs and allows a higher production capacity. This technique will be used on a pilot line for the MY 79 FIOD automatic transmission manufacturing program.
	NICKEL-CHROME COATED STAMPED ALUMINUM VIA ALCOA 661 PROCESS	Ford produced 10,000 chrome plated aluminum bumpers on a pilot plating line in Monroe, Michigan. The Alcoa 661 process does not require cyanide and replaces the Alston 80 cyanide plating process. Ford's MY 79 Panther line rear bumper is the first industry use of Alcoa's 661 process.
	RIM PRODUCTION (REACTION INJECTION MOLDING)	Utica, Michigan trim plant has a production and a lab system for the development of future plastic applications. The cost to Ford for both systems was $700,000-$1,000,000 and includes:

TABLE 3-3. MANUFACTURING PROCESSES USED BY FORD (Concluded)

MY		
		Production System - 5 clamping machines (or presses) and one chemical metering machine.
		Laboratory System - 1 - 2 presses.
1981-1985	ELECTRON BEAM OR LASER WELDING	The company is planning to use this method of welding in the production of a single plane manifold split in 2 (rather than 4 or 5) pieces.
	FILAMENT WINDING	Ford may use filament-wound graphite/epoxy driveshafts if production becomes more economical.

TABLE 3-4. INNOVATIONS IN COMPONENTS: FORD

BRAKES	1979	Permanent molded aluminum master brake cylinders on some models.
HOODS	1977	First use on Ford autos: Aluminum Hoods on selected Lincoln Versailles models (supplied by Reynolds).
	1978	Heavy duty truck cabs have hoods made of aluminum alloy 6009.
ROOFS	1977	Special roofs become very popular. Most are installed by customizers. Some installed by manufacturers.
SEATS	1977	Partial rear seat back panel assemblies made of aluminum were installed on some wagons.
FRAME	1978	Fairmont/Zephyr HSLA steel 980XK substituted for plain carbon steel in the sill area.
SUSPEN-SION	1978	Fairmont/Zephyr has a MacPherson like front suspension with the coil spring separate from the strut. This design saves space. The mountings are made of galvanized HSLA steel.
		Rear suspension arms and brackets are made of galvanized HSLA steel.
	1981-1985	Graphite/epoxy leaf springs may be possible in 1981-85.
DOORS	1978	Fairmont/Zephyr door impact beams are HSLA steel.
WHEELS	1973	Pinto offered first forged aluminum styled wheel.
	1974-76	Ford expanded use of forged aluminum styled wheels (Maverick, Mustang, Granada).
	1977	Ford first styled forged aluminum wheel became standard equipment (Versailles). Aluminum wheels offered on all other luxury cars.
TIRES	1977	Radials installed on 80-90% of all Ford autos.
	1977	Media reports several tire manufacturers testing non-flat tires with special lubricant-cooler insert in hopes of eliminating spare tire.
	1978	Ford compacts have high pressure (60 psi) compact spare tire which saves 11-14 lbs.
	1980	Expect 100% radials installed by 1980.

TABLE 3-4. INNOVATIONS IN COMPONENTS: FORD (Continued)

BUMPERS AND FRONT ENDS	1970	Mustang sported Ford's first soft (urethane) front end.
	1973	Mustang sported both soft (urethane) front and rear ends.
	1974	Ford and Lincoln/Mercury offered polygel mitigator energy absorbers (PGM's) on small cars for low-speed impacts.
	1977	High strength anodized aluminum bumper became standard equipment in 1977 Pinto; Bobcats; and 1978 Granada; Monarch.
	1978	Ford: HSLA steel reinforcements and mild steel face bars are used on Ford, Mercury, LTD II, Cougar, X/R-7, T'bird, Granada, Monarch and Versailles.
		Aluminum reinforcement for a mild steel face bar is used on Continental, and Mark V. An extruded aluminum face bar is on Fairmont, Zephur, Pinto, and Bobcat.
		HSLA reinforced-urethane face bars are on Mustang II.
	1979	Panter Line: (Downsized standard size) - First industry use of chrome-plated aluminum bumpers. (On 1/5 of Panther line).
		Ford Model Line Station Wagons - 100,000 cars with extruded chrome-plated aluminum front bumpers and anodized rear.
		Mercury Station Wagon - 25,000 with chrome-plated aluminum rear bumpers and anodized front bumpers.
		Mustant III and Mercury Capri III Specialty Cars - RIM soft urethane front end (2nd OEM user).
FUEL TANK	1978	Fairmont/Zephyr have cold rolled HSLA steel fuel tank reinforcements.
WINDOW BRACKETS	1977	Plastic replaces galvanized steel in LTD II and Cougar XR-7.
FASTENERS	1977	Media reported the redesign of the hex head flange bolt to save weight. However, the new bolt was not in production as of May, 1977.

TABLE 3-4. INNOVATIONS IN COMPONENTS: FORD (Continued)

ENGINE/ DRIVETRAIN COMPONENTS		10-year plan consists of phasing in aluminum engine components, including the cylinder block. Total aluminum/car in 1985: 200-250 lbs. (6-8%); in 1977: 100 lbs. (3%).
INTAKE MANIFOLDS	1978	Granada and Monarch V-8 engines have aluminum intake manifolds.
	1981-1985	Two-piece single plane aluminum intake manifold planned for production via die casting.
TRANSMISSION CASE	1977	Media reports the SR-4, 4-speed manual transmission used in the 1977 and later Mustang II models. Weighs 58 lbs.
REAR AXLES	1978	Rear axles are lighter and more efficient: 1978 Fairmont/Zephyr, 1979 Mustang III, Capri IV, Pinto, Bobcat, LTD, and Marguis Wagons.
DRIVESHAFT	1981-1985	Graphite/epoxy driveshaft is possible.
ROCKER ARMS	1979 or 1980	Production of stamped rather than cast iron rocker arms is planned for V-8 engines.
WATER PUMP	1979	Models with V-8 engines loaded with options will have a die cast Aluminum 309 water pump. Weight savings: 8 lbs.
BEARINGS	1978	Sealed bearings used on Ford Fiesta with front wheel drive.
ENGINE CONTROL DEVICES	1978	Electronic Engine Control (EECI) installed on Versailles models with small V-8 engines.
	1978	Pintos and Bobcats with automatic transmission for the California market have closed-loop or feedback air/fuel ratio controls. Suppliers: Motorola, Ford.
	1979 & 1980's	Ford expects digital EFI control to be in production for 1979 model year and to be in wide use in 1980.

TABLE 3-4. INNOVATIONS IN COMPONENTS: FORD (Concluded)

EMISSION CONTROL	1978	Fairmont/Zephyr use a 2-section catalytic converter containing both a 3-way oxidation/reduction catalyst and a conventional oxidation unit.

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GENERAL TRENDS IN WEIGHT REDUCTION

CTP - KD 11/8/77 F. pl

FORD		MEDIA REF. BOOK NO.	REFERENCES
Fiesta	Interchangeable front & rear bumpers	2-Misc. 16	AI 7/15/77 p. 18
Fairmont & Zephyr	Plastics: inner fenders Cowl top vent grille battery trays Seat back (some metal)	2-F	WAW 9/77 p. 43
Fairmont/Zephyr	All Al bumpers, front & rear	2-F	WAW 9/77 p. 43
	Al steering gear housing Al power steering pump housing	2-F	WAW 9/77 p. 44
	Steel door impact beams	2-F	WAW 9/77 p. 44
	HSS rear suspension arms and brackets HSS front shock absorber	2-F	WAW 9/77 p. 44
	1/8" thick front and rear door windows (glass) - sedans } thinner than Maverick & Comet Front door glass and backlights 5/32 in. thick } 33% more total glass area	2-F	WAW 9/77 p. 46
Aluminum in Luggage Area	Specifically partial rear seat back panels in some station wagons, as part of the luggage load floor assemblies Al Alloy 5182 0.045" gauge Mercury Wagon weighs 40 lbs. (includes 18-19 lbs. auxiliary panels) 1010 steel weighs 84 lbs. } save 45-55% K-Pinto/Bobcat 11 lbs. 25 lbs. }	2-F	AMM/MN 1/10/77 p.22
	Results of materials substitution: Each wagon involved can be slotted in the desirable inertia weight class for optimum engine calibration. Used in California models to offset additional, heavy emission controls.	2-F	AMM/MN 1/10/77 p.22
Composites	Julius J. Hardwood, Ford. Material Science Laboratory, Director Composites containing graphite or carbon fibers will appear in autos in 1980-1985.	2-F	AMM/MN 1/31/77 p. 8
Fasteners	Save 4,500 tons fastner material (mostly steel) each year by reducing head sizes of bolts and screws in cars and trucks.	2-F	WAW 4/77 p. 54

FIGURE 3-2. FORD WORKSHEET

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

CTP - KD 11/8/77 F. p2

FORD		MEDIA REF. BOOK NO.	REFERENCES
Approach to weight reduction	Revamp models from bottom up	2-F	B.W. 5/23/77 p. 100
Fairmont & Zephyr	Weight = ~ 3,000 lbs. : 300 lbs. less than Maverick & Comet	2-F 2-F	B.W. 5/23/77 p. 100 U.S.News and World Report 9/26/77 p. 30
Ford Executive:	By 1985 cars will have approximately 1,000 lb. less steel, twice as much Al and Plastic, Lower Axle ratios, and more aerodynamic design.	2-F	WAR 5/30/77 p. 171
Dr. W. Dale Compton, V.P. Research	A virtually all-plastic car will be technically feasibly by mid 1980's. Pace determined by price and pressure to improve fuel economy. Powdered metal technology - a key to hiking parts - manufacture productivity. S. African politics important for noble base catalytic converters. Battery development progressing. There is a future for electric cars. Consumer demands are increasing.	2-F	WAW 12/76 p. 60
Weight Reduction: Fairmont	1. Computerized structural analysis 2. Expanded use of light weight materials 3. Re-design of some vehicle components Bumpers: light weight extruded Al Thinner doors and seat backs	2-F	AN 9/5/77 p. 14
Weight Reduction: Corporate Strategy	All models: 1. Wider use of plastics, aluminum, HSLA steel and thin glass. Also use of smaller, lighter power - steering pump on most all models (appro. 5 lbs. lighter).	2-F	AN 9/5/77(Ford) p. 14 (Merc) p. 18
Interior - Cloth	Cars and vans: 55% cloth, 35% vinyl, 10% leather	2-GM	WAW 9/77 p. 59
	Cylinder heads for V-8 engine - Ford 1980-81 Al intake manifolds Ford 1979 (V-8 engines) All plastic front seats 1980 Ford Soft plastic Rim front/rear end panels 1979 (Mustang & Capri) Hi-strength plastic radiator supports (intermediates) 1980 Mustand 4-speed manual transmission SR-4 = 58 lb. (Al case cover & extension housing)	2-Misc.	WAW 6/77 p. 26

FIGURE 3-2. FORD WORKSHEET (Concluded)

3.3 CHRYSLER

3.3.1 Subject Area

This section includes information on Chrysler Corporation's weight reduction strategy and expectations of meeting the 1985 fuel economy goals. It presents an overall view of Chrysler's progress and announced future plans for:

1) weight reduction via component re-design and material substitution,
2) materials usage,
3) manufacturing processes directly impacting on weight reduction potential.

The information found in this section is compiled from two sources:

1) articles found in Media Reference Book 2, and
2) summaries found in sections 4 and 5 of this volume.

3.3.2 Indexing Method - Worksheets

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to weight reduction strategies: WEIGHT REDUCTION APPROACH, WEIGHT REDUCTION DETAILS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. (See Figure 3-3.)

3.3.3 Summaries

The following tables included in this section present an overview of Chrysler Corporation's weight reduction strategy:

TABLE 3-5. MANUFACTURING PROCESSES USED BY CHRYSLER
TABLE 3-6. INNOVATIONS IN COMPONENTS: CHRYSLER CORPORATION
TABLE 3-7. MATERIALS USAGE ON CHRYSLER CORPORATION AUTOS

TABLE 3-5. MANUFACTURING PROCESSES UTILIZED BY CHRYSLER

1977	Warm forming for high strength aluminum: Process developed by Chrysler reduces the heat cycle from over 60 minutes to 2 minutes.
1978	Electron beam welding used to assemble 2-piece aluminum die cast manifolds for MY 78 Volare/Aspen.
	Permanent mold casting or sand casting used to make a 1-piece aluminum intake manifold for MY 78 V-6 engines.
1979	Chrome plated aluminum bumpers to be used on MY 79 R-cars. Bumpers are pre-treated prior to slating using the Alston 80 (Cyanide) method.

TABLE 3-6. INNOVATIONS IN COMPONENTS: CHRYSLER CORPORATION

BUMPERS	MY 78 Volare/Aspen:	Chrome plated high strength steel face bars.
	MY 78 Horizon/Omni:	Chrysler's first all-aluminum bumper.
	MY 78½ Fury/Monaco:	One-piece HSLA steel bumper.
	MY 79 R-Cars:	First industry use of chrome-plated aluminum bumpers on production cars.
BRAKES	MY 78 Valiant Galant:	Series IV light-weight disc brakes with aluminum body and nodular iron bridge.
ENGINE/ DRIVETRAIN PARTS	MY 78 Chrysler:	Lean burn is available on all 8-cylinder engines.
	MY 78 Horizon/Omni:	Have front wheel drive.
	MY 78 trucks:	Nissan diesel is available.
	MY 78 Volare/Aspen:	Two piece die-cast manifold assembled with electron beam welders.
	MY 78 V-6 engines:	One piece aluminum intake manifold made by sand casting or permanent mold casting.
	MY 80 Optional aluminum cylinder block in some V-8 engines.	
	MY 80 Aluminum cylinder head on the V-8/318.	
	Long Range Plans:	Conversion of cast iron engine parts to aluminum and thinner gauge cast iron.
WHEELS	MY 77 Diplomat/LeBaron:	Optional styled forged aluminum wheels.
	MY 79 R-cars:	First application of fabricated aluminum wheels on production cars.
TIRES	MY 78 Testing the run-flat tire.	
FASTENERS	1974 began standardization program which has cut fastener use 20%.	
ELECTRONICALLY CONTROLLED ENGINE DEVICES	MY 78 Introduction of an analyzer that can trouble-shoot 60 different engine functions in less than 4 minutes and supply printed information to the mechanic.	

TABLE 3-7. MATERIALS USAGE ON CHRYSLER CORPORATION AUTOS

ALUMINUM

1977	Styled forged aluminum wheels offered as options on the Diplomat and LeBaron.
1978	Disc brakes with aluminum alloy 3331 caliper body and a nodular iron bridge (made by Bendix) are offered on the Valiant and Galant.
	Fabricated aluminum wheels. Production begins 7/1/78 for MY 79 R-body autos.
	Aluminum bumper. MY 78 Horizon and Omni have Chrysler's first all aluminum bumpers.
	First industry use of 2-piece die cast intake manifolds assembled with electron beam welders for MY 78 Volare and Aspen.
	First one-piece aluminum intake manifold made by permanent mold casting or sand casting for MY 78 V-6 engines.
1979	First application of fabricated aluminum wheels on production cars: MY 79 R-body autos.
	First application of chrome plated aluminum bumpers on production cars: MY 79 R-body autos.
1980 and beyond	Aluminum cylinder head is planned for the V-8/318.
	Long range plans call for conversion of cast iron manifolds for 8 cylinder engines to aluminum.
	Aluminum cylinder block is a possibility.

TABLE 3-7. MATERIALS USAGE ON CHRYSLER CORPORATION AUTOS (Concluded)

STEEL	
1977	Chrysler uses all HSLA bumper face bars.
1978	Plymouth Volare, Dodge Aspen - Chrome-plated HSLA steel on front and rear bumper face bars.
1978½	First company use of one-piece, HSLA steel bumper in recent years. Installed as midyear change on front ends of all intermediate-size Plymouth Fury and Dodge Monaco.
PLASTICS	
	No innovative applications noted.

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GENERAL TRENDS IN WEIGHT REDUCTION

CHRYSLER		MEDIA REF. BOOK NO.	REFERENCES
Engine Wt. Reducing Program Phases:	I More Al castings: Al intake manifold & oil pump housing - 1979 II 1979-80 Thinner wall primary castings (engine block) and light-wt. crankshaft III Beyond '80 - all Al cylinder head	2-C	WAR 2/14/77 p. 49-50
HSS Bumper Face Bars	Rear - saves 7 lbs./car LeBaron Front- saves 23 lbs./car Fury & Monaco	2-C	WAW 9/77 p. 44
Horizon/Omni	One-piece body sides "unisides" - sheet metal stampings	2-C	AMM/MN 5/9/77
XL Experimental Intermediate	HSS and Aluminum; Hood, Deck Lid, Bumpers, Cowl, Floor Pan	2-C	AMM/MN 5/16/77 p. 5

FIGURE 3-3. CHRYSLER WORKSHEET

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GENERAL TRENDS IN WEIGHT REDUCTION

CTP - KD 11/8/77 C p.2

CHRYSLER

		MEDIA REF. BOOK NO.	REFERENCES
Wt. Reduction : How (Plymouth/Dodge)	1. Re-design parts w/lightening holes (steel panels) (not mentioned for Dodge) 2. parts w/HSLA steel/Al replacing regular steel 3. Use of lighter - wt. glass & fabrics	2-C 2-C	AN 9/12/77 p. 22 AN 9/12/77 p. 10
Wt Reduction: details (Plymouth)	Company cars average 300 lbs. wt. loss in 1978.	2-C	AN 9/12/77 p. 22
Components	12 lbs. saved via cast Al intake manifold (Volare) 24 lbs. saved via HSLA steel in bumpers (face bars Volare & Aspen = 24 lb. savings WAW 9/77 - p. 44). 6.2 lbs. saved via 2 piece Al master cylinder w/plastic resevoir 1.0 lb. saved via plastic "scrapers" replacing rubber boots on bumper energy absorbers 2.0 lbs. saved via molding windshield washer resevoir as an integral part of the battery thermoguard heat shield.		
Models (Ply/Dodge) Volare Charger SE	 thin-back front seats (60/40 w/warm rest only) thin-back bucket seats	2-C 2-C	AN 9/12/77 p. 22 AN 9/12/77 p. 10
Dodge-Intermediates	Weight approximately 300 lbs. less than 1977 counterparts.	2 Misc.	WAW 9/77 p. 43 AN 9/12/77 p. 10
4-Cyl. Engine	Cast Fe: blocks & heads Al: intake manifolds & water pumps thin-wall construction } size approximates overhead cam Pinto engine (Ford - 1978)	2-C	WEU 9/2/77 p. 1
Dodge V-8 Cars	Plastic air shields in engine compartments	2-C	WAW 9/77 p. 43
Dodge/Plymouth Intermediates	Plastic bumper guard cushions save 6.5-8.5 lbs/car Plastic scrapers on energy absorbers 1-piece design windshield washer resevoir	2-C	WAW 9/77 p. 43
Horizon/Omni	Extruded Aluminum bumpers	2-C	WAW 9/77 p. 43
Al Intake Manifold (die cast)	6 cylinder Volare & Aspen Models	2-C	WAW 9/77 p. 44
Some Chrysler cars have	2-piece Al master brake cylinder	2-C	WAW 9/77 p. 44

FIGURE 3-3. CHRYSLER WORKSHEET (Continued)

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

CHRYSLER		MEDIA REF. BOOK NO.	REFERENCES
Approach to Wt. Reduction	Abandon its full-sized car models entirely at end of '77 model year. Maintain limited production of largest cars. Strengthen position in small-car market via Horizon and Omni.	2-C	B.W. 5/23/77 p. 101
Aluminum Wheels	1979; - Chrysler will save 60 lb./car.	2-C	B.W. 5/23/77 p. 101
Engines	6/225 - lose 105 lbs. } time limit 3-4 years. via Aluminum components 8/318 - lose 70-120 lbs. } thinner than normal iron castings	2-C	AMM/MN 5/2/77 p. 14 WEU 6/10/77 p. 1
	8/318 } optional Al cylinder head for 1980 - save approx. 50 lbs. } standard Al intake manifold.	2-C	AMM/MN 5/2/77 p. 14 WEU 6/10/ 77 p. 8
	6/225 wt. (current) = 542 lbs. } complete engine pkg. including accessories and 8/318 = 614 lbs. } related components up to and including torque converters.	2-C	AMM/MN 5/2/77 p. 14 WEU 6/10/77 p. 1
	8/318 wt. reduction by 1980 6/225 wt. reduction by 1981	2-C	AMM/MN 5/2/77 p. 14
Aluminum	Chrysler seeking stronger Al alloys for a variety of potential applications in cars; new bonding adhesives, fasteners and better warm-forming methods for Al components.	2-C	AMM/MN 5/2/77 p. 14
Interior Cloth	40% cloth, 50% Vinyl, 10% leather - consistent use for 5 years.	2-C	WAW 9/77 p. 59
Approach to Weight Reduction	Eliminated Ply.Gran Fury & Chrysler Newport Sedan Import 2 small luxury Japanese cars Ply. Sapporo; Dodge Challenger Introduces U.S. built minis: Horizon and Omni.	2-C	U.S. News & World Report 9/26/77 p. 30
Chrysler Engineer	1981-82 are "crisis" years. Must lop off 600 lbs./car; use light weight engines and change sales mixes to hit 22 mpg @ 1982.	2-C	WAW 9/12/77 p. 293

FIGURE 3-3. CHRYSLER WORKSHEET (Concluded)

3.4 AMERICAN MOTORS CORPORATION

3.4.1 Subject Area

This section includes information on American Motors Corporation's weight reduction strategy and expectations of meeting the 1985 fuel economy goals. It presents an overall view of AMC's progress and announced future plans for:

1) weight reduction via component re-design and material substitution,
2) materials usage,
3) manufacturing processes directly impacting on weight reduction potential.

The information found in this section is compiled from two sources:

1) articles found in Media Reference Book 2, and
2) summaries found in sections 4 and 5 of this volume.

3.4.2 Indexing Method - Worksheets

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to weight reduction strategies: WEIGHT REDUCTION APPROACH, WEIGHT REDUCTION DETAILS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. (See Figure 3-4.)

3.4.3 Summaries

The following tables included in this section present an overview of American Motor's weight reduction strategy:

TABLE 3-8. MATERIALS USAGE ON AUTOS AND LIGHT TRUCKS: AMERICAN MOTORS CORPORATION

PLASTICS	In 1980-81, AMC is estimated to use 26-28 lbs. of ABS plastic/vehicle as opposed to the previously estimated 21-22 lbs./vehicle
ABS	The MY 77 Pacer contains 38 lbs. of ABS plastic in 70 parts. CYCOLAC Z-48, a high heat ABS plastic, is used on the MY 78 Concord's instrument panel. MY 76 Jeep vehicles debut structural foam molding of large parts with a removeable top.
STEEL	AMC's bumpers are made of all mild steel with steel re-inforcements with the exception of the MY 78 Pacer. The Pacer has HSLA steel bumpers. Weight savings: 30 lbs.
ALUMINUM	The Pacer, Hornet, and Cremlin offer a SR-4, 4-speed optional transmission with an aluminum case. Weight savings: 20 lbs.

TABLE 3-9. INNOVATIVE COMPONENTS: AMERICAN MOTORS CORPORATION

BUMPERS	All mild steel with steel reinforcements. MY 78 Pacer has HSLA steel face bars (saves 30 lbs.)
MAJOR BODY PARTS	Since MY 76 Jeep vehicles offered a removeable top made of structural foam molding. The instrument panel of the MY 78 Concord is made of CYCOLAC Z-48, a high heat ABS plastic.
ENGINE/DRIVETRAIN PARTS	The diesel is used by MY 78 Jeep overseas. An aluminum transmission case on the SR-4, 4-speed optional transmission saves 20 lbs. on the Pacer, Hornet and Gremlin. The optional quadra-trac 2-speed/4-speed drive transfer case supplied by Warner Gear for Jeep vehicles saves 110 lbs.
BATTERY FOR ELECTRIC CARS	AMC is involved in electric car research and manufacture in the U.S.

WORKSHEET

CTP - KD 11/8/77 A p. 1

GENERAL TRENDS IN WEIGHT REDUCTION

AMC		MEDIA REF. BOOK NO.	REFERENCES	
Approach to weight reduction task	Continues to seek niches in small-car market	2-AMC	B.W. 5/23/77	p. 100
Concord	Modeled on the Hornet compact. Numerous luxury items built into Sticker price. AMC/s only "new" car.	2-AMC	U.S.News & World Report 9/26/77	p. 30
Concord	Replaces Hornet 2982-3105 lbs. (2-dr./wagon). No major weight reduction methods used (1978)	2-AMC	AN 8/29/77	p. 20
Pacer, Gremlin Matador AMX	No major weight reduction methods used in 1978.			
Transmissions	Weight savings between 3 speed manual and optional 4 speed = 20 lb. (9.07 kg) Quadra-Trac transfer case Cast Fe = 210 lb. actual wt = 100 lb. (Jeep)	2-Misc.	AI 7/1/77	p. 36
Pacer	HSS bumpers - 30 lbs./car savings	2-Misc.	WAW 9/77	p. 44

FIGURE 3-4. AMERICAN MOTORS WORKSHEET

3.5 MISCELLANEOUS

3.5.1 Subject Area

This section includes information on weight reduction methods currently being used or proposed by automotive manufacturers and component and material suppliers but which are not directly attributable to a particular automotive manufacturer.

3.5.2 Indexing Method - Worksheets

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to weight reduction strategies: WEIGHT REDUCTION METHOD, WEIGHT REDUCTION DETAILS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. (See Figure 3-5.)

3.5.3 Summaries

The following table summarizes the information found in this section:

TABLE 3-10. 'RULES OF THUMB' FOR WEIGHT REDUCTION

TALBE 3-10. 'RULES OF THUMB' FOR WEIGHT REDUCTION

Cost of shedding weight: $1.00/lb.

Cost penalty for material substitution (Aluminum or plastics for low carbon steel or cast iron): 200%

The fixed relationship between overall vehicle weight and driveline weight has been a flat curve. It is now changing.

An aerodynamic drag formula will be used on MY 79 cars to correct EPA mileage estimates to 1-2% error.

Fuel economy estimations: 400 lbs. (181 kg) weight loss results in 3 mpg (1.3 kml) gas savings.

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

CTP - KD 11/8/77 MI p. 1

MISCELLANEOUS

		MEDIA REF. BOOK NO.	REFERENCE
	Major factor in fuel economy is lighter weight	2-Misc.	MT 4/77 p. 30
Trend (Industry)	Fewer sheet metal stampings. Entire sections are consolidated into one piece. "Unisides" at Chrysler.	2-Misc.	AMM/MN 5/9/77
Electric Cars	Great Britain, before the 1980's will see considerable Lucas electric vehicles in use	2-Misc.	MT 6/77 p. 15
Composites Graphite carbon Aramid	Will replace steel, aluminum, conventional plastic, and cast iron parts.	2-Misc.	WAW 4/77 p. 53
Magnamite	Continuous graphite fiber priced at $18/lb. (previous low was $32/lb.)		
Fabricated Al Wheels	Less costly and lighter wt. than forged/cast. Production applications by 1979.	2-Misc.	WAW 4/77 p. 53
Plastics	Soft nose bumper system w/no steel backing - prototype of Davidsons next generation of plastic units w/o metal.	2-Misc.	WAW 4/77 p. 53
Aluminum	Al honeycomb inside doors to absorb side impacts.	2-Misc.	WAW 4/77 p. 53.

FIGURE 3-5. MISCELLANEOUS WORKSHEET

CTP - KD 11/8/77 MI p. 2

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

MISCELLANEOUS		MEDIA REF. BOOK NO.	REFERENCE
Aerodynamic drag formula	To be used for 1979 models. Corrects EPA mileage estimates to 1-2% error.	2-Misc. 15	WEU 6/10/77 p. 7
Formulae	400 lbs. (181 kg) wt. loss = 3 mpg (1.3 kml) gas savings	2-Misc.	AI 9/1/77 p. 45
Most used materials (lbs.)	1. Fe 3. Rubber 5. Glass #3 & #4 to exchange places this year. 2. Steel 4. Plastics	2-Misc.	AI 9/1/77 p. 45
Glass bubbles	3M's B37/2000 bubbles Extends polyester resin in sheet molding compound (SMC) 250-300 mill lb. of SMC expected in 1980 models --- 35 lbs./car. Wt. savings = 10.5 lbs. or 30% = 18 gal. of gas over life of car.	2-Misc.	AI 9/1/77 p. 45
Inertia Wt. Classes	Proposed change:125 lb. "steps" up to 4,000 lbs. 250 lb. "steps" from 4,000-5,500 lbs.	2-Misc.	AN 9/12/77
	Manufacturers group vehicles at the top end of the inertia weight cutoff points	2-Misc. 15	AN 9/12/77 p. 49
Glass	Trend toward thinner and lighter weight: windows, backlights, and windshields, hatch roofs. Exposed area is becoming greater w/larger windows, etc. e.g. Fairmont has 33% more total glass area than Maverick.	2-Misc.	WAW 9/77 p. 46
Galvanized Steel	Type of steel making greatest gains in U.S. Market. May meet head on w/zincrometal	2-Misc.	WAW 4/77 p. 54 WAW 9/77 p. 46
Zincrometal	Use is rising dramatically. Die casting Zn. has fallen off.	2-Misc.	WAW 4/77 p. 54 WAW 9/77 p. 46
Electric Vehicles	Lighter materials of prime importance. Attack on 2nd and 3rd car family market is 5-6 years away.	2-Misc.	AMM/MN 5/2/77 p. 1 Boston Globe 6/19/77 p. E-1

FIGURE 3-5. MISCELLANEOUS WORKSHEET (Continued)

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

CTP - KD 11/8/77 MI p. 3

MISCELLANEOUS

		MEDIA REF. BOOK NO.	REFERENCE
Thin walled casting w/interlocking cores	3.0 lb. wt. savings. Wall thickness reduced from 0.21 inches to 0.19 inches.	2-Misc.	AI 7/1/77
Torque converters	Light gauge sheet steel } also Al case pump, starter, turbine torque converters bell housing - saves 14 lb. over cast design. Wt=35 lbs. T-50 transmission case = 65 lbs. M29 auto transmission = 93 lbs. 28 lb. savings	2-Misc.	AI 7/1/77 p. 37
Magnamite	Continuous graphite fiber @ $18/lb. Hercules Industrial Products high stiffness, low wt., versatility of fabrication vibration damping, friction reduction, noise suppression, chemical inertness Best applications - driveshafts, suspension elements	2-Misc.	AI 7/1/77 p. 38
Composites	Use in leafsprings, drive shafts, wheels, coil springs	2-Misc.	AI 7/1/77 p. 39
Fixed Relationship	Between overall vehicle wt. and driveline wt. Curve has been flat. Is changing.	2-Misc.	AI 7/1/77 p. 39
Bearings	Plastics, nylon or delrin are most promising for bearing cage applications.	2-Misc.	AI 7/1/77 p. 23
Silicon Nitride bearings	Silicon Nitride - non-metallic: used to form rolling elements; cost of each bearing = $100. Cost prohibitive. Strict future material.	2-Misc.	AI 7/1/77 p. 24
Powdered Metal Bearings	Used in heavy duty trucks. Better mfg. control w/powdered metal than with steel. Process = Sinta forging.	2-Misc.	AI 7/1/77 p. 24
Lubricants	Quality is critical in sealed for life components, e.g., bearings.	2-Misc.	AI 7/1/77 p. 25
Future bearing design	SKF Generation III: combines function of hub and bearing together for a smaller package for front ends.	2-Misc.	AI 7/1/77 p. 26

FIGURE 3-5. MISCELLANEOUS WORKSHEET (Continued)

CTP - KD 11/8/77 MI p. 4

WORKSHEET

GENERAL TRENDS IN WEIGHT REDUCTION

MISCELLANEOUS		MEDIA REF. BOOK NO.	REFERENCE
Cost penalty material substitution	Substituting Al/plastics for low carbon steel or cast Fe - Cost penalty - 200%	2-GM	BW 5/23/77 p. 101
Cost of shedding Weight	$1/lb. currently considered a maximum	2-GM	BW 5/23/77 p. 101 AI 6/1/77 p. 31
Impact of other Federal Standards on fuel economy	Current air cushion design - increase wt. by 62 lb. (28 kg)/car	2-GM	AI 6/1/77 p. 31
Downsizing costs GM	Large cars - $1.1 billion 400,000 annual vehicles: $300-$500 mill and $200 reduction of variable costs/car, i.e., twice the NHTSA estimate. Other programs may have fewer caryyover parts.	2-GM	WEU 5/13/77 p. 4
Weight reduction details	'78 Olds 98 Regency - saved 2½ lbs. using 1202 velour instead of 1602.	2-GM	WAW 9/77 p. 59
Interior fabrics	Formed on-seats molded trim of knit velour (Monte Carlo bench seat) Tooling required..costly. Eventually price reduced, design originalit-enhanced, backing strength increased; less material needed therefore (wt. loss realized). Will be used in '79.	2-GM	WAW 9/77 p. 59
Aluminum future in Autos	Forecasts of 576 lbs. Al/car in 1985. Al ingot characterized by energy costs and low profits: delay in capacity expansion.	2-GM	WAW 6/77 p. 45
New Applications for materials	Doors of plastic/metal composites, or sandwiches Plastic transmission valve bodies. Mg end caps/fender extensions Wheels - hi strength, glass fiber reinforced plastic HSS door panels, front suspension cross members, and underbodies Al radiators, honeycomb door components. Plastic bumper reinforcements Increased use of plastic fender extensions and end caps, aluminum wheel, water pumps, and brake parts, HSS bumper face bars. Thin out existing components and materials.	2-GM	WAW 6/77 p. 26

FIGURE 3-5. MISCELLANEOUS WORKSHEET (Concluded)

4. MATERIALS

4.1 GENERAL MIX MATERIALS

4.1.1 Subject Area

This section includes information on materials that are not specifically designated for another section; e.g., glass, copper. It emphasizes applications and manufacturing processes specific to the automotive industry.

4.1.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to new technology and applications: MATERIAL, PROCESS, SUPPLIER, AUTO MANUFACTURER, COST, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Worksheets pertaining to General Mix Materials are found in Appendix A, Figure A-1.

These columns allow the reader to quickly scan for information which is most relevant to his current needs. For example, a search for information on glass indicates that per car consumption of glass increases even though thinner, lighter weight glass is used.

4.1.3 Summaries

This section also includes a summary sheet, TABLE 4-1. APPLICATIONS OF GENERAL MIX MATERIALS IN THE AUTOMOBILE, which lists, by material, historical and projected use of components and processes.

TABLE 4-1. APPLICATIONS OF GENERAL MIX MATERIALS IN THE AUTOMOBILE

Copper	Marston Radiators, England has a new radiator design which allows the use of an automated production line and one step soldering. Washing prior to painting the finished product is unnecessary due to the use of a non-corrosion low residual flux. This method decreases production (15%) and labor (35%) costs and heating fuel and water used.
	Copper radiators become smaller with the downsizing of cars.
Glass	The trend toward thinner, lighter weight glass continues. Per car consumption of glass increases, however, due to increases in total glass area, e.g., glass sunroofs, larger than normal windshields, wraparound backlights.

4.2 ADHESIVES

4.2.1 Subject Area

This section includes information on adhesives. It emphasizes innovations and research conducted in new materials and advances in manufacturing processes specific to the Automotive Industry. It also includes information on specific applications of adhesives in cars and trucks.

4.2.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the use of adhesives in automobiles: AUTO MANUFACTURER, ADHESIVE SUPPLIER, ADHESIVE, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to Adhesives are found in Appendix A, Figure A-2.

4.2.3 Summaries

This section also includes a summary sheet, TABLE 4-2. ADHESIVE APPLICATIONS AND SUPPLIERS IN THE AUTOMOTIVE INDUSTRY, which lists current and future applications of adhesives in automobiles and those suppliers and research organizations involved in the development of these applications.

TABLE 4-2. ADHESIVE APPLICATIONS AND SUPPLIERS IN THE AUTOMOTIVE INDUSTRY

CURRENT APPLICATIONS:

1. Adhesives are replacing rivets, small screws and clips in plastic-to-metal applications:
   - auto side trim
   - gaskets
   - dashboards
2. Adhesives are not expected to replace conventional fasteners where disassembly is necessary or in structural welding applications.

FUTURE APPLICATIONS: (1980's)

1. Use of structural adhesives to join structural plastic parts. This application is predicated on the development of a cost-effective finish for plastic parts.
2. Adhesives for metal-to-metal bonding system.

SUPPLIERS AND RESEARCH ORGANIZATIONS:

FASSON DIVISION, Avery International,
Painsville, Ohio - Non Structural Adhesives

Expects a 30% per year growth in replacing mechanical fasteners with adhesives.

STRUCTURAL ADHESIVES DIVISION, Goodyear,
Ashland, Ohio - Structural Adhesives

Uses a systems approach to bonding in order to encourage the use of adhesives and bonding method.

GENERAL MOTORS, Fisher Body Division -
Metal-to-Metal Bonding Systems Research

4.3 ALUMINUM

4.3.1 Subject Area

This section includes information on Aluminum emphasizing innovations and research conducted in new alloys and advances in manufacturing processes specific to the automotive industry. It also includes information on specific applications of aluminum components in cars and trucks.

4.3.2 Indexing Method

Since worksheets contain abstracts of articles in a random sequence, columns have been created for specific information relevant to the manufacture of Aluminum and Aluminum Automotive Components: AUTO MANUFACTURER, ALUMINUM SUPPLIER, PROCESS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Components are underlined in the text of the abstract. These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to Aluminum are found in Appendix A, Figure A-3.

4.3.3 Summaries

Three summary sheets are included in this section:

TABLE 4-3. APPLICATIONS OF ALUMINUM PROCESSES IN THE AUTOMOTIVE INDUSTRY, lists historical and projected innovative processes which are in use or are available to manufacturers.

TABLE 4-4. ALUMINUM ALLOYS IN THE AUTOMOTIVE INDUSTRY, lists new and experimental alloys which are currently available.

TABLE 4-5. APPLICATION OF ALUMINUM COMPONENTS IN AUTOMOBILES, lists significant historical and projected uses of aluminum components.

TABLE 4-3. APPLICATIONS OF ALUMINUM PROCESSES IN THE AUTOMOTIVE INDUSTRY

1974	TI Superform Worcester, England	First reported use of "Supral" stamping process for aluminum body parts. Supral sheets are heated to 450°F and formed. At this temperature the alloy becomes superplastic and capable of ten times elongation without fracturing. After forming it retains all mechanical properties of conventional Aluminum. This process is most suitable for medium production runs (100-10,000 pieces).
1976	Alcoa	Offers royalty-free process in order to promote usage of Z-7046 experimental alloy for bumpers. This process (661 process) includes the pre-treatment of chromium plated aluminum bumpers via a non-cyanide method. It replaces the Alstan 80 cyanide method.
1977	Chrysler	Media reports that Chrysler's new warm forming process for high strength aluminum has an innovative 2-minute heat cycle. Previous heat cycles were longer than 60 minutes.
	Alcoa	Begins production of commercial quantities of 6009/6010 alloys for inner/outer panel combinations. These alloys are compatible for scrap.
	General Motors (Chevrolet) and Ford	Media reports purchase of low pressure casting equipment for MY 1978 auto components. Low pressure casting is used overseas more extensively than in the U.S. Claims for its superiority over conventional casting include: 1) higher yields in the casting wt/metal poured ratio (low pressure casting yields = 90-95% or higher; 2) decrease in manufacturing energy consumption; 3) lower tooling costs. It is also a better casting method for large parts. Ford is evaluating this process.
1979	Chrysler	Kelsey-Hayes Co. will produce the first aluminum wheels. Manufactured on conventional tooling (fabricated aluminum wheels) which will be used on a production car (R-car)

TABLE 4-4. ALUMINUM ALLOYS IN THE AUTOMOTIVE INDUSTRY

"Supral"	Aluminum alloy containing 6% copper and 0.5% zirconium. When heated to 450°F Supral becomes superplastic and capable of ten times elongation without fracturing. When cooled after forming, it assumes all mechanical properties of conventional aluminum.
2036-T4 and 5182-0	Inner/outer combination for body sheet applications. These alloys are not compatible for scrap.
6009 and 6010	Inner/outer combination for body sheet applications. These alloys are compatible for scrap and will replace 2036-T4 and 5182-0.
Z-7046	Alcoa's experimental alloy for bumpers. It is offered with the royalty free 661 process to encourage switches to Aluminum bumpers.
High Strength Aluminum Alloys	Mechanical properties comparable to those of structural steel are obtained by heat treating certain aluminum alloys. Aluminum and hardening metals are heated sufficiently (approximately 920-930°F) to dissolve and disperse the hardening agents. The alloy is then quenched rapidly in cold water to retain the hardening metals in solid solution and the part is aged at room temperature.

TABLE 4-5. APPLICATION OF ALUMINUM COMPONENTS IN AUTOMOBILES

YEAR	MANUFACTURER	EVENT	COMPONENT
1970	General Motors	Introduction of Vega's all-aluminum engine.	Engine
	General Motors (Buick)	Introduction of Buick's aluminum rear brake drums.	Rear Brake
1974	General Motors	First major expansion of aluminum usage in autos. Debut of aluminum bumpers on the Camaro and Vega/Astre.	Bumpers
1977	General Motors (Oldsmobile)	First usage of aluminum hoods on production cars.	Hood
	Ford	Partial rear seat back panel assemblies made of aluminum installed on some wagons.	Rear Seat Back Panel Assembly
	Ford	Aluminum bumpers become standard equipment on the Pinto and Bobcat.	Bumper
	General Motors	Vega 4-cylinder aluminum engine is discontinued.	Engine
	Porsche	Media Reports on all new aluminum engine modeled after the Vega aluminum engine.	Engine
1978	Hayes Albion	Begins production of aluminum intake manifolds for Ford in March.	Intake Manifolds
	Ford	Initiates production volume use of aluminum power steering pump housing and rack and pinion steering gear housing.	Steering Pump Housing
	General Motors (Chevrolet)	Lemans - soft face bumper system includes an advanced concept in flexible chrome bumper moldings.	Steering Gear Housing
	General Motors (Buick, Oldsmobile, Pontiac)	Aluminum rear brake drums become standard equipment on the Intermediates.	Bumper Rear Brake Drums
1979	Ford	Will install permanent molded aluminum master brake cylinders on some production models.	Master Brake Cylinder
	Chrysler	R-Cars. First application of fabricated aluminum wheels on production cars.	Wheels
	Chrysler	R-Cars. First application of chrome-plated aluminum bumpers on production cars.	Bumpers
1980	Chrysler	Aluminum cylinder head is planned for the V-8/318.	Cylinder Head
	All manufacturers	Increase of aluminum wheels usage on production cars is expected.	Wheel
1981-1985	All manufacturers	Wholesale swing to aluminum wheels on production cars is expected.	Wheel
	Ford	Two-piece single plane intake manifold ready for production via die casting of aluminum.	Intake Manifold
	Ford	Production of aluminum cylinder heads via molding will be possible.	Cylinder Heads

4.4 CATALYSTS

4.4.1 Subject Area

This section includes information on the metal catalysts used in current anti-pollution 2 and 3-way catalytic converters, e.g., platinum and rhodium.

4.4.2 Indexing Methods

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the use of catalysts in automotive components: MATERIALS, SUPPLIER, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to Catalysts are found in Appendix A, Figure A-4.

4.4.3 Summaries

This section also includes a summary sheet which details suppliers and expected demand for each material, TABLE 4-6. CATALYST MATERIALS.

TABLE 4-6. CATALYST MATERIALS

Platinum	The active material in current converters. Rustenburg Mines Ltd., So. Africa supplies 70% of the free world's platinum group metals. It is owned at least in part by Anglo American Ltd., So. Africa (see below: Rhodium).
Rhodium	Most effective material for the 3-way catalyst. Leading supplier, Englehard Minerals and Chemicals Corporation, is owned in part (28.6%) by Anglo American Ltd., So. Africa. Rhodium will be used with platinum in some MY '78 converters. Its use will widen after MY '78.

4.5 CERAMICS

4.5.1 Subject Area

This section includes information on ceramics. It emphasizes innovations and research conducted in new materials and advances in manufacturing processes specific to the automotive industry. It also includes information on specific applications of ceramic components in cars and trucks.

4.5.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacture of ceramics and ceramic automotive components: MATERIAL, PROCESS, SUPPLIER, AUTO MANUFACTURER, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Components are underlined in the text of the abstract. These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to Ceramics are found in Appendix A, Figure A-5.

4.5.3 Summaries

This section also includes a summary sheet, TABLE 4-7. APPLICATION OF CERAMICS IN THE AUTOMOBILE, which lists historical and innovative uses of ceramic components for automobiles.

TABLE 4-7. APPLICATION OF CERAMICS IN THE AUTOMOBILE

1977	Johns-Manville	Underhood engine insulation Cerawool and Cerablanket uses an exclusive needling process which interlocks ceramic fibers. It is widely used as insulation for catalytic converters.
	Aluminous Keatite Ceramic	Now under development: Ceramic heat exchanger for automobile turbines (material used: lithium aluminum silicate).
	Eaton Corporation	Now under development: Ceramic engine rocker arms weighing half as much as metal rocker arms now being used. Brittleness is the major problem.
	Ford	Ceramic pistons will not be used in PROCO stratified charge engine.

4.6 CHROME

4.6.1 Subject Area

This section includes information on chrome. It emphasizes advances in manufacturing processes specific to the automotive industry and specific applications of chrome-coated components in cars and trucks.

4.6.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacture of chrome-coated automotive components: MATERIAL, PROCESS, SUPPLIER, AUTO MANUFACTURER/MODEL, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Components are underlined in the text of the abstract. These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to Chrome are found in Appendix A, Figure A-6.

4.6.3 Summaries

This section also includes a summary sheet, TABLE 4-8. APPLICATIONS OF CHROME PROCESSES IN THE AUTOMOTIVE INDUSTRIES, which lists innovative processes which are currently in use or are available to all manufacturers.

TABLE 4-8. APPLICATIONS OF CHROME PROCESSES IN THE AUTOMOTIVE INDUSTRIES

Chrome Sputtering	Process used by General Motors's Chevrolet Division as a less expensive and more efficient alternative to electroplating. Used to coat ABS plastic components with chrome. First production application was on MY '77 Caprice lower grilles. Other General Motors divisions (Guide Division, Anderson, Indiana) plan to use it in MY '78 and later.
Vacuum Metalizing	This process is used to coat plastic with Aluminum and is being adapted for chrome plating. It is similar to chrome sputtering and is less expensive and more efficient than conventional electroplating. General Motors will be using this process.
Electroplating	Current method for chrome coating materials used in auto components.

4.7 IRON

4.7.1 Subject Area

The information in this section contains data on the use of iron in automobiles.

4.7.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to the use of iron in automobiles: MATERIAL, COMPONENT, PROCESS, SUPPLIER, AUTO MANUFACTURER, MODEL, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles most relevant to his current needs. Worksheets pertaining to iron are found in Appendix A, Figure A-7.

4.7.3 Summaries

In addition, this section includes a summary table, TABLE 4-9, APPLICATIONS OF IRON IN THE AUTOMOBILE, which lists historical and projected innovative uses of iron in automobiles.

TABLE 4-9 APPLICATIONS OF IRON IN THE AUTOMOBILE

January 1977	New cast iron rear axle hypoid gears become standard on General Motors full-size station wagons and Cadillacs. Iron gears are comparable to steel gears in durability but are lighter (2 lbs. on Pontiac gear set) and quieter. Also, production is less energy intensive and less expensive.

4.8 LUBRICANTS

4.8.1 Subject Area

The information in this section contains data on various types of lubricants including synthetic and natural oils and dry films.

4.8.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to lubricant technology and applications: LUBRICANT MANUFACTURER, NAME OF LUBRICANT, TYPE OF LUBRICANT, COST, GAS SAVINGS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on lubricant manufacturers who offer advanced lubricants to the public indicates six manufacturers which are involved: EXXON, MOBIL, ARCO, and PENNZOIL offer motor oils. Climax Molybdenum Company offers a gear lubricant. Acheson offers dry film permanent lubricants. Worksheets pertaining to lubricants are found in Appendix A, Figure A-8.

4.8.3 Summaries

The summary sheet included in this section (Figure 4-1) consolidates the information found in the worksheets and presents an overview of developments in automotive lubricant technology by the type of lubricant. It was derived from the worksheets by scanning the TYPE OF LUBRICANT column.

In addition, this section contains TABLE 4-10. SIGNIFICANT DEVELOPMENTS IN AUTOMOTIVE LUBRICANTS, listing historical and projected developments in lubricant technology which impact on automotive applications.

TABLE 4-10. SIGNIFICANT DEVELOPMENTS IN AUTOMOTIVE LUBRICANTS

1951	EXXON	Introduction of Uniflo, the first multiviscosity oil in production.
1976	MOBIL	Introduction of Mobil 1, a synthetic motor oil. Sources report automakers will privately admit Mobil 1 meets warranty provisions.
1977	ATLANTIC RICHFIELD	Introduction of Arco-graphite enriched motor oil.
	EXXON	Introduction of an improved version of Uniflo, containing soluble friction modifiers: composition of modifiers was not disclosed.
	MOBIL ARCO PENNZOIL	Media reports these firms are conducting research on a product similar to Uniflo.

General Motors, Chrysler, and Ford are all testing new lubricants. Ford sources report that synthetic oils, graphite enriched oils, and motor oil and gear lubricants with molybdenum disulfide (MoS_2) meet company specs. Before automakers can use them in production cars, however, warranty testing must be completed and EPA must approve the lubricants.

LUBRICANTS SUMMARY CTP - MCI 12/7/77 LU p. 1

AUTO OR LUBRICANT MANUFACTURER	NAME OF LUBRICANT	NOTES	COST	FUEL ECONOMY	MEDIA FILE BK.	MEDIA FILE SEC.	REFERENCE
Ford		Motor Oil with Molybdenum Disulfide (MoS_2) Molyblends meet company specs (according to sources at Ford). Ford is working with SAE on development of ratings.		Unquestioned	3	LU	WEU 9/30/77 p. 6
		Gear Lubricant With Molybdenum Disulfide (MoS_2)					
		Cannot be used in EPA rating tests becaust it's not readily available to general public.			3	LU	WEU 9/16/77 p. 6
		Axle efficiency can improve from 1% to 40%. Added to entire power train, fuel efficiency could improve 10-15%.			3	LU	AE 11/77 p. 56
		Ford Motor Co. - Computer simulation modifying viscosity - temp. behavior and functional properties. Insufficient data to determine fuel economy of 3% MoS_2 and 3% graphite lubes.		Small for CVS and EPA highway cyles. 5% at low temp.			
		Used in Chasis Grease, Front wheel bearing grease, Hypoid gear oil.					
Acheson	Emralon ^{R} (PTFE) Dag ^{R} (graphite) Molydag ^{R} (MoS_2)	Permanent Lubricant Dry film used in valve stems, cams, gas caps, ashtrays, sun roofs, solenoid plungers, 26 different parts of the carburetor. Benefits: resist rust and corrosion. -impervious to gas, greases, oils, and water.			3	LU	Advertisement Acheson

FIGURE 4-1. LUBRICANTS SUMMARY SHEET

LUBRICANTS SUMMARY CTP - MCI 12/7/77 LU p. 2

AUTO OR LUBRICANT MANUFACTURER	NAME OF LUBRICANT	NOTES	COST	FUEL ECONOMY	MEDIA FILE BK.	MEDIA FILE SEC.	REFERENCE
		Motor Oil - Synthetic					
		Cannot be used in EPA rating tests because it's not readily available to general public.		Average increase 4-5% mpg.	3	LU	AN 9/26/77 p. 49
		Care must be taken in switching to synthetic engine oil: 1--Synthetic engine oil must meet weight and service specifications as outlined in owners' manufal. 2--Synthetic oils may not mix well so best to stick to one brand. 3--Change synthetic oil at 5000 mile intervals according to warranty. Can be costly.	$12.00 plus filter and labor.		3	LU	RT 11/77 p. 164
Mobil	Mobil 1	Reduces oil consumption: engine wear. Extends oil change intervals up to 15,000 miles or one year.	$3.95/qt.	Average increase 5% mpg.	3	LU	WAW 8/77 p. 25
		Meets engine warranty provisions although manufacturers reluctant to admit it.			3	LU	WSJ 8/25/77 p. 21
	Syn 1	SAE-5W-20 Tested. Short trip: 6 miles, cold start, urban/highway = 40%/60%. Oil economy for engines which don't leak, extended oil drain intervals.		Average 5% mpg. increase	3	LU	AE 6/77 p. 56
		Savings from mpg improvement overrides small increase in energy required for production.		1 barrel Syn 1 = 6.6 barrels crude oil			
Ford		Sources at Ford say synthetic oils meet company specs. Do not doubt fuel economy claims. Ford is working with SAE on development of ratings.			3	LU	WEU 9/30/77 p. 6

FIGURE 4-1. LUBRICANTS SUMMARY SHEET (Continued)

LUBRICANTS SUMMARY CTP - MCI 12/7/77 LU p. 3

AUTO OR LUBRICANT MANUFACTURER	NAME OF LUBRICANT	NOTES	COST	FUEL ECONOMY	MEDIA FILE BK.	MEDIA FILE SEC.	REFERENCE
		Motor Oil with Soluble Friction Modifiers					
EXXON	Uniflo	Improved version: super-premium 10W-40 motor oil exceeds car makers requirements, 1500 miles to condition engine. Based on road test data, average savings = 3¢ gal. of gasoline.	$1.40/qt.(slightly more than multi-grade oils).	4.5% average increase 16 miles per tankful after conditioning	3	LU	Sales Brochure New Uniflo Motor Oil Conserves Gasoline Saves Money Exxon Co. 1977
	Uniflo	First version	$1.15/qt.		3	LU	WSJ 8/25/77 p. 21
Mobil Atlantic-Richfield Penzoil		Working on product similar to Uniflo			3	LU	WEU 9/2/77 p. 16
		Motor Oil-Graphite Enriched					
Atlantic Richfield	ARCO-Graphite	Reduces engine wear. Turns oil coal black.	$1.55/qt.	Increases mileage 8.7%	3	LU	WAW 8/77 p. 25
		Most natural graphites are marginally abrasive; synthetic graphites will not form an adherent film on a ferrous substrate.	Expensive		3	LU	WSJ 8/25/77 p. 21
Ford		Graphite blends meet company specs and fuel economy expectations. Is working with SAE on ratings for friction reducers.			3	LU	WEU 9/30/77 p. 6

FIGURE 4-1. LUBRICANTS SUMMARY SHEET (Concluded)

4.9 MAGNESIUM

4.9.1 Subject Area

This section includes information on magnesium. It emphasizes advances in manufacturing processes specific to the automotive industry and applications of magnesium components in cars and trucks.

4.9.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacture of magnesium automotive components: MATERIAL, TOOLING, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Components are underlined in the text of the abstract. These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to magnesium are found in Appendix A, Figure A-9.

4.9.3 Summaries

This section also includes a summary sheet, TABLE 4-11. APPLICATION OF MAGNESIUM IN AUTOMOBILES, which lists historical and projected uses of magnesium processes and components

TABLE 4-11. APPLICATION OF MAGNESIUM IN AUTOMOBILES

1977	Magnesium : Aluminum price ratio is 2:1.
	There is approximately ¼ lb. of Magnesium per car.
	Cost of aluminum increases.
	Need to conserve energy increases.
	Ford experiments with use of small die-cast Magnesium components.
	Hot chamber die-casting machinery does not exist for the manufacture of large components.
1985	Estimates of Magnesium used per car 2:1 Mg:Al price ratio - Only ¼-½ lb. Mg/car 1.5:1 Mg:Al price ratio - 20 lbs. Mg/car.

4.10 PAINT

4.10.1 Subject Area

This section includes information on paints. It emphasizes innovations and research conducted in new paint materials and advances in manufacturing processes specific to the automotive industry.

4.10.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the use of paint in cars and trucks: MATERIAL, AUTO MANUFACTURER, MEDIA REFERENCE BOOK NUMBER, and REFERENCE, (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to paint are found in Appendix A, Figure A-10.

4.10.3 Summaries

Two summary sheets are included in this section:

TABLE 4-12. APPLICATIONS OF PAINTS IN THE AUTOMOBILE, lists historical and projected uses of different paint materials and colors.

TABLE 4-13. USES OF PAINTS BY AUTOMOBILE MANUFACTURERS, lists the paint materials and processes currently used by auto manufacturers.

TABLE 4-12. APPLICATIONS OF PAINTS IN THE AUTOMOBILE

1930's	Corrosion resistance was not a problem since fenders were thick and there was no road salt. Fewer than ten colors were suitable for automotive paint. No light colors were suitable.
Post World War II	Increase in the number of colors suitable for cars. Aluminum flake was added to enamel to produce a metallic sheen.
1953	Ford successfully introduced white cars.
1955-1959	Introduction of acrylics and improved resins suitable for metallic-finish look. Two toned color combinations became popular. 69 different colors offered.
1960	Colors offered dropped to 29 due to production costs and marketing problems.
1970's	Number of colors offered ranged from 15-20.
1975	Water based paints became important because of solvent emissions restrictions issued in Los Angeles.
1977-1978	GM truck lines switch from alkyd enamels to acrylic enamels for increased corrosion-resistance. GM uses Elpo, a rust-resistant cathodic electro-deposition resin primer.
Mid 1980's	Use of water-based enamels and high-solid finishes increase due to environmental standards.

TABLE 4-13. USE OF PAINTS BY AUTOMOBILE MANUFACTURERS

General Motors	Uses lacquers on all cars. This method can be a low energy user if paints are air-dried, rubbed and polished. General Motors uses a bake method which consumes more energy. General Motors assembly plants in Los Angeles have switched to water-based enamels due to high atmospheric hydrocarbon levels attributable to lacquer solvents. This uses a high energy process which requires baking car bodies at 325^{o}F and closely controlling humidity via air conditioning equipment.
Ford, Chrysler and American Motor Company	Use enamels and lacquers. Generally use the air-dry, rub and polish method for lacquers. Polyurethane enamels provide a deep, wet-looking finish, are resistant to chemicals, have a high solid content and require low (150^{o}F) baking temperatures. However, they do not produce a metallic finish and may present health hazards due to the resin, isocynate and acrylic or polyester components.
Volkswagen Mfg. Corp. of America	Does not use water-based paints. Uses high solid content Alkya melamine enamel finishes. Finishes will be purchased from American suppliers.
Paints generally not used	Powders cannot take metal finishes. Extensive and expensive changes must be made to convert to this paint. The application process, however, could be an energy saver. Acrylic Paints controversy exists over the health hazard due to acrylonitrile. OSHA has not ruled on this as of September, 1977.

4.11 PLASTICS

4.11.1 Subject Area

This section includes information on plastics. It emphasizes innovations and research conducted in new materials and advances made in manufacturing processes specific to the automotive industry. It also includes information on specific plastic components in cars and trucks.

4.11.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacture of plastic and plastic automotive components: AUTO MANUFACTURER, SUPPLIER, MATERIAL, PROCESS, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). Components are underlined in the text of the abstract. These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to plastics are found in Appendix A, Figure A-11.

4.11.3 Summaries

Three Summary Sheets are included in this section:

TABLE 4-14. MATERIALS IN THE PLASTIC INDUSTRY, lists new and experimental materials which are currently available for use in automobiles.

TABLE 4-15. APPLICATIONS OF PLASTIC PROCESSES IN THE AUTOMOTIVE INDUSTRY, lists innovative forming and finishing processes which are in use or are available to manufacturers.

TABLE 4-16. PLASTIC COMPONENTS IN AUTOMOBILES, lists significant historical and projected uses of plastic components in automobiles.

TABLE 4-14. MATERIALS IN THE PLASTICS INDUSTRY

PLASTICS	- Moldable materials manufactured from high molecular weight organic polymers other than natural and synthetic rubbers. The basic resins consist of carbon combined with hydrogen, oxygen, nitrogen, chlorine, fluorine, silicon and other elements. These resins are usually compounded with plasticizers, stabilizers, fillers, dyes and pigments to obtain specific properties desired for commercial application.
THERMO-PLASTIC MATERIALS	- One of two groups of plastic materials based on their behavior towards heat. Thermoplastics are permanently fusible. They soften when heated, harden when coated and decompose when exposed to very high termperatures. Examples of thermoplastics: vinyl, styrene, polyethylene, cellulosic plastics, nylon, polysulfone, and polyphenylene sulfide (PPS).
THERMO-SETTING PLASTICS	- One of two basic groups of plastic materials based on their behavior towards heat. They may be permanently infusible and are classified into three stages of chemical and physical properties. 1. Initial condensation product - A solid or liquid which is both fusible and soluble. 2. Intermediate product - Insoluble and difficult to fuse but can be molded via heat and pressure. 3. Final product - Has a permanent set and maximum hardness, strength, resistivity and insolubility. Examples of thermosetting materials include: phenolics, polyesters, epoxies, melamines, and sheet molding compounds (SMC).
MOLDING COMPOUNDS	- Consist of resins inpregnated with strengtheners. The compounds are cured by compression, transfer or extrusion molding into void free parts. Mechanical properties of the molding compounds exceed those of conventional thermoplastics and thermosets.
SHEET MOLDING COMPOUNDS	- A glass fiber reinforced thermoset plastic. XMC and HMC are improvements of the basic SMC.
CYCOLAC 2-48	- A high heat ABS plastic developed for unpadded instrument panels that extend to the windshield and require more heat resistant material. Used on AMC's Concord.

TABLE 4-14. MATERIALS IN THE PLASTICS INDUSTRY (Concluded)

COMPOSITE MATERIALS

COMPOSITE MATERIAL -	A combination of two dissimilar materials into a new material with improved characteristics. The structural arrangement of the component materials may vary and could include: 1. Fibers of high strength material embedded in a matrix. 2. Short, high-strength crystal "whiskers" dispersed in a matrix. 3. Materials combined in alternate layers. 4. A metal honeycomb filled with a matrix material. Fiber-glass reinforced plastic is one of the most common and least expensive composites.
ADVANCED COMPOSITES/ HIGH PERFORMANCE COMPOSITES -	Composite materials composed of organic-based fibers incorporated into a matrix of some thermoset or thermoplastic material. Organic-based fibers include aramid and carbon fibers.
HYBRIDIZED COMPOSITES -	Composite materials formed with a mix of different high-strength fibers. Hybridization can increase flexural strength and impact strength and decrease the cost of total high performance fiber use.

TABLE 4-15. APPLICATIONS OF PLASTICS PROCESSES IN THE AUTOMOTIVE INDUSTRY

FORMING PROCESSES

Thermoplastic Stamping	Ford (Maumee, Ohio) converted metal stamping equipment to plastic forming applications in order to use a proprietary stamping process developed in 1976. This equipment was used for the manufacture of MY '78 fender liners for F Series Light Trucks. Eight hydraulic presses were ordered to provide additional capacity for the manufacture of fender liners for autos.
Structural Foam Molding	Either high or low pressure equipment can be used. Structural foam was first used for the MY '76 Jeep (AMC) removable top. The media reports (8/8/77) a new process suitable to large production parts.
Compression Molding	In this process plastic material is introduced into an open mold and is shaped via heat and pressure on closing. Improvements to this method are involved with the use of in-mold primers.
Injection Molding	Shapes are molded via injection of a measured quantity of the molten plastic into dies.
Reaction Injection Molding	This process is based on the high-speed injection of reactive liquids into a mold. Production cycle times are much shorter than with regular injection molding.
Extrusion	In this process either hot or cold semi-soft plastic is forced through the orifice of a die to produce a continuously formed piece in the shape of the desired product.
Poltrusion	This process compares with extrusion and is used in the manufacture of advanced components. Continuous fibers are pulled through a resin bath and a heated die.
Filament Winding	This process is especially suitable for the manufacture of driveshafts and torsion bars made from advanced composites. Liquid resin is applied simultaneously as layers of fiber are laid upon a mandrel or as part of a sandwich construction. Fibers can be built up at various orientations within the constraints of equipment geometry. This method is time consuming and involves high equipment costs.

FINISHING PROCESSES

In Mold Primers	GM's Chevrolet Division is working with General Tire and Rubber Company on the development of in-mold primers for compression molded plastic body parts. This process will be first used on MY '79 Corvette roofs. It permits the design of thinner plastic panels with built in strengthening sections and eliminates post mold priming time and some finishing expenses.
Chrome-Sputtering	This method of chrome plating is used for finishing soft and rigid plastic components. If successful, it could increase the use of plastic components in the auto, especially the use of plastic bumpers. It was used by GM's Guide Division, Anderson, Indiana on MY '77 Caprice components and by Chevrolet, Flint, Michigan for MY '78 and MY '79 components. Guide will also use it on MY '79 components.

TABLE 4-16. PLASTIC COMPONENTS IN AUTOMOBILES

MY	COMPONENT	MFG/MODELS
1976	Removeable top - Debut of structural foam molding of large parts.	AMC - Jeep Vehicles
1977	Rigid plastic lower grilles coated via chrome-sputtering	GM - Chevrolet Caprice
	Nylon (glass reinforced) injection molded steering column housing replaces zinc housing.	GM - Chevrolet Vega
1978	RIM polyurethane bumper replaces steel bumpers with hydraulic shock absorbers.	VW- Dasher
	Stamped thermoplastic fender liners replace metal fender liners	Ford - "F" series Light Trucks
	Molded plastic radiator supports to replace steel units by the end of MY 78.	GM - Chevrolet Division
	Soft faced bumper system:	
	Soft plastic Guide Flex bumpers, front and rear have a painted plastic outer skin, polyethylene honeycomb energy absorbers and aluminum impact beams.	GM - Chevrolet Monte Carlo
	Soft faced bumper system:	
	RIM urethane skin combined with stamped, glassfiber reinforced polypropylene retainer and metal backing bar.	GM - Pontiac LeMans
	RIM molded facia.	GM - All Intermediates
	Soft plastic nose.	GM - Chevrolet Camaro
	SMC front end panels.	GM - Chevrolet Caprice Classic
	Plastic front end panels.	GM - Chevrolet Monte Carlo Buick Malibu Malibu Classic
	Plastic fender liners.	GM - Buick Malibu Malibu Classic Chevrolet Monte Carlo Century Regal
1979	ABS plastic grilles coated via chrome-sputtering.	GM - Chevrolet Chevette
1981-1985	Filament wound graphite/epoxy driveshafts.	Ford
	Fiberglass springs for passenger car.	Owens-Corning
	Reinforced plastic sliding door for wagon van.	GM
	Delrin steering column switch assembly.	Kostal
	Aramid belted radials.	Dupont Goodyear

4.12 SCRAP

4.12.1 Subject Area

This section includes information on scrap materials emphasizing the effect of the scrap market on auto manufacturers and suppliers. It includes information on the availability and processing of ferrous scrap in the automotive industry.

4.12.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacturer and distribution of scrap: MATERIAL, TOOLING, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to scrap are found in Appendix A, Figure A-12.

4.12.3 Summaries

This section also includes a summary sheet which details factors impacting on the price and availability of scrap, TABLE 4-17. SCRAP.

TABLE 4-17. SCRAP

The scrap market has been affected by a drop in the price and a decrease in the availability of ferrous scrap.

1977 Price Drop:	Prices per ton dropped monthly from an average of $75.38 to $58.30. Scrap is less reliable in terms of its physical and chemical characteristics. The price may be depressed as much as $10/ton when it is contaminated with zinc (e.g., scrap from galvanized steel and zincrometal).
Decreasing Availability	Scrap generated by Big 3 Auto Makers in 1977 is not significantly down from prior years despite car designs using less steel. A current trend in manufacturing is to increase the efficient use of steel and decrease the amount of scrap sold to processors.

4.13 STEEL

4.13.1 Subject Area

This section includes information on steel. It emphasizes innovations and research conducted in new materials and advances made in manufacturing processes specific to the automotive industry. It also includes data on specific steel components used in cars and trucks.

4.13.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacture of steel and steel components: MATERIAL, PROCESS, SUPPLIER, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles most relevant to his current needs. Worksheets pertaining to steel are found in Appendix A, Figure A-13.

4.13.3 Summaries

TABLE 4-18. STEEL PROCESSES IN THE AUTOMOTIVE INDUSTRY, describes innovative forming and finishing processes in use by or currently available to auto manufacturers.

TABLE 4-19. MATERIALS USED IN STEEL AUTOMOTIVE COMPONENTS, describes new and experimental materials which impact on the use of steel in automobiles.

TABLE 4-20. STEEL COMPONENTS IN AUTOMOBILES, lists significant historical and projected uses of steel components.

TABLE 4-18. STEEL PROCESSES IN THE AUTOMOTIVE INDUSTRY

1970		CONVENTIONAL TECHNIQUES used to produce and form mild steel can be used with HSLA (high strength low alloy) steels with minor modifications, for example, in spot welding HSLA generally requires 10% less welding current, 25% more electrode force, and 10% longer cycle time. These advantages in production rates, cost, availability and capital equipment make HSLA very competitive with other lightweight materials.
Late 1970's		First reported in 1922, recent technological improvements and reduced finish-machining costs make P/M (POWDER METALLURGY) HOT PRESSING desirable for the production of complex steel components which would be difficult to melt and cast suitably. The hot pressing operation is conducted in a completely closed die set at a temperature usually lower than that for conventional forging. Overrunning clutch races, connecting rods, differential gears, and brake parts are among those components being produced or seriously considered for automotive use.
1976	GM	Experimental THERMOMECHANICAL TREATMENT (TMT) process starts with a low-cost steel (without alloys vanadium, niobium or titanium with lower yield and tensile strength, which is easier to form, has less springback and allows lower press loads. Through sufficient work hardening and age hardening of the part, the strength can be increased up to 80,000 psi (pounds per square inch) while having a thinner gage than current HSLA Steel. Experimental applications include truck bumpers, auto bumper reinforcements and bumper brackets. Major obstacle to implementing the TMT process may be the initial capital equipment costs.
1977	U.S.Steel	Process called CAROSEL (CONSUMABLE-ANODE RADIAL ONE-SIDED ELECTROPLATING) is being used to produce steel sheet which is electroplated with zinc on one side only. The new metal, USS Galva-ore, was developed primarily for use as automotive exterior body panels (available 1978 MY) since the outside would be left bare for paint while the inside was protected against corrosion. Because corrosion protection is applied to metal before fabrication, the coating is more complete and uniform so it could be used to make many other complex components which would be better protected than when coated after fabrication.
1977	Battelle Labs., Columbus, Ohio	Beginning a two year study of FRED (FAST-RATE ELECTRODEPOSITION) process which would make carbon steel corrosion-resistant by applying chromium to surface layer only, rather than by conventional bulk alloying. Preliminary tests indicate process is more efficient in its use of chromium and energy as well as having lower production costs than the conventional methods.

TABLE 4-19. MATERIALS USED IN STEEL AUTOMOTIVE COMPONENTS

MILD STEEL	Ordinary commercial quality steel used in auto components has carbon content between 0.8 and 0.5%. Yield strength of mild steel is generally in the rang of 30-50,000 psi. Excellent ductility (absence of brittleness), formability and welding characteristics.
HIGH STRENGTH LOW ALLOY (HSLA)	Use of High Strength Alloy (HSLA) Steels in autos increased dramatically as part of effort by manufacturers to reduce or maintain the weight of components while meeting strength and increased safety standards for crash worthiness. Generally, HSLA steels have a low carbon content in the range of 0.1 to 0.15% and a low alloy content of 0.1 to 1.5% manganese, modified with small amounts of columbium, vanadium or titanium. Yield strength of HSLA steel is generally in the range of 50-80,000 psi. Formability characteristics of HSLA steel have been improved greatly since 1970.
980X	A variety of HSLA steel under study for wider application by General Motors. It forms as though its yield strength is 50,000 psi, but strain hardens to 80,000 psi.
GALVA-ONE	One-sided electrogalvanized sheet metal developed by U.S.Steel primarily for use as automotive exterior body panels. Zinc applied by CAROSEL Process (consumable-anode radial one-sided electroplating).
POWDERED METALS	Steel powder contains a much lower oxygen content than standard powders. This material was developed for the hot pressing process which requires a special, cleaner powdered metal.
SCRAP	Scrap is essential to the production of steel and steel components. A shortage of scrap is anticipated which could increase production costs for steel makers and auto makers. Several reasons for shortage include: 1) steelmakers are improving their methods and production yield so in-house supplies of scrap are decreasing 2) automakers are also improving their efficiency and cutting the availability of industrial scrap usually sold to processors 3) the quality of scrap available is less reliable in terms of physical and chemical characteristics because alloyed and plated steels, such as zinc electroplate, are harder to prepare for recycling 4) growth in electric furnace steel making capacity requires more scrap. See Scrap section 3.12 in this volume for further information.

TABLE 4-20. STEEL COMPONENTS IN AUTOMOBILES

YEAR	MFG.		COMPONENT
1976	GM	Chevette master brake cylinder reservoir is lighter weight stamped steel instead of cast iron (developed by U.S.Steel).	Brake Cylinder
	GM	Chevy Monza 2 + 2 experimental bumper met 1980 safety standards. 10 lbs. lighter than plastic assembly.	Bumpers
1977	GM	Downsized standard-size cars have galvanized HSLA steel floor pans, outer wheel house.	Floor Pans Outer wheel house
1978	Chrysler	Volare and Aspen bumpers have stamped and chrome-plated HSLA steel front and rear face bars instead of mild steel. Weight reduction of 24 lbs.	Bumpers
	Chrysler	Diplomat and LeBaron bumpers have HSLA steel face bars which reduce weight by 7 lbs.	Bumpers
	AMC	Pacer saves 30 lbs. with HSLA steel bumpers.	Bumpers
	Ford	Fairmont and Zephyr rear suspension arms and brackets, front shock absorber mountings are made of galvanized HSLA steel.	Suspension Shock Absorbers
	Ford	Fairmont and Zephyr door beams are cold rolled 70,000 psi HSLA steel	Door beams
1978	GM	Intermediates have one-piece stamped (instead of roll form) HSLA door impact beams. Some beams are hot-rolled 80,000 psi HSLA steel. Some beams are cold rolled 60,000 psi HSLA steel.	Door beams
	Ford	Fairmont and Zephyr frame have HSLA steel 980XK substituted for plain carbon steel in sill area.	Frame
	Ford	Fairmont and Zephyr have cold rolled HSLA steel fuel tank reinforcements.	Fuel tank
1979 or 1980	Ford	Plans to produce stamped instead of cast steel rocker arms for V-8 engines.	Rocker arms
1980's		(As reported in the media 8/29/77) Steelmakers expect expanded use of HSLA steels.	
		Cold-rolled 45-60,000 psi range yield strength for body, panels, hoods, doors, structural components, car floors.	Body panels Hoods Doors Floors
		Hot-rolled 80,100,000 psi range yield strength for car frames, suspensions.	Frame Suspension
1983		(As reported in media 6/6/77) Steelmakers expect steel content in autos to drop an average of 700-800 lbs. per car compared with 1977 MY.	

4.14 ZINC

4.14.1 Subject Area

This section includes information on zinc. It emphasizes innovations and research conducted in new alloys and advances in manufacturing processes specific to the automotive industry. It also includes information on specific applications of aluminum components in cars and trucks.

4.14.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the manufacturer of zinc and zinc automotive components: MATERIALS, PROCESS, SUPPLIER, AUTO MANUFACTURER, MODEL, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. Worksheets pertaining to zinc are found in Appendix A, Figure A-14.

4.14.3 Summaries

This section also includes a summary sheet, TABLE 4-21. APPLICATIONS OF ZINC IN THE AUTOMOBILE, which lists significant uses of zinc components and corrosion-resistant zinc alloys in 1977 and 1978 model year vehicles.

TABLE 4-21. APPLICATIONS OF ZINC IN THE AUTOMOBILE

COMPONENTS

Die Castings	The trend is toward thin-walled zinc die castings. These are replacing thicker zinc die castings rather than other materials. Energy requirements by weight of material are lower for zinc than for plastic. (Zn: $.41/lb.; Plastic $1.02/lb.). MY '77 cars and trucks employ 60-80 new applications for zinc die castings including: fender extensions, headlamp housings, corner lamp housings, opera window moldings, door handles, grille frame, etc.

CORROSION RESISTANCE

The use of zincrometal, galvanized steel and zinc-rich coatings in the automobile has probably peaked in MY 77 and MY 78 since most areas of the car are now protected. Advances in corrosion resistance will come from improved processes and coatings, not necessarily containing zinc, e.g., cathodic electrodeposition of paints. Ferrous scrap contaminated with zinc sells at a depressed price.

Zincrometal	Sheet metal coated with a corrosion-resistant zinc-rich paint. The coating process was developed and patented by Diamond Shamrock. Zincrometal is used by Ford.
Galvanized Steel	Steel coated with corrosion resistant zinc on either one or both sides via hot-dip or electro-galvanizing methods. Galvanized steel is used by General Motors and Chrysler.

5. COMPONENTS

5.1 BRAKES

5.1.1 Subject Area

This section includes information on various types of brakes, for example, disc and drum.

5.1.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to brake technology and applications: SUPPLIER, AUTO MANUFACTURER, MODEL, MATERIALS, COST, FUEL ECONOMY, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on the activities of auto manufacturers indicates Chrysler and General Motors are using aluminum to reduce the weight of brakes in some 1977 and 1978 production models.

Worksheets pertaining to brakes are found in Appendix B, Figure B-1.

5.1.3 Summaries

The summary sheet (Figure 5-1) included in this section presents an overview of innovations in brake technology. It was derived from the worksheets by quick referencing under component and incorporates easy index systems. Additional summary sheets can be prepared by quick referencing under other column topics.

Additionally, this section includes TABLES 5-1. SIGNIFICANT APPLICATIONS OF BRAKE INNOVATIONS IN THE AUTOMOBILE, which lists historical, current and projected innovations in brake technology.

TABLE 5-1. SIGNIFICANT APPLICATIONS OF BRAKE INNOVATIONS IN THE AUTOMOBILE

MY	MFG.	
1970	GM	Buick offered aluminum rear brake drums to increase cooling efficiency of brakes.
1977	Chrysler	Light weight disc brakes with new design offered for small cars on Valiant Galant.
1978	GM	Buick, Olds, Pontiac Intermediates use lighter weight aluminum rear brake drums, which were last used in 1970.

BRAKES

SUMMARY SHEET

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COMPONENT	MATERIALS	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT. RED.	MEDIA REF. BOOK NO.	REFERENCES
Rear Brake Drums	Aluminum	Aluminum rear brake drums used on '78 models as weight reduction technique. Prior use was on 1970 Buicks for rapid heat dissipation.		GM	'78 Buick, Olds, Pontiac Intermediates	Lower Weight	4 BR	WAR 9/29/77 p. 275
Disc Brakes	Al. alloy 3331 caliper body. Nodular iron bridge	Series IV light-weight disc brakes for small cars. Reduces drag of disc brake sifnigicantly.	Bendix	Chrysler	Nov. 1977 Valiant Galant	33-54% less than iron.	4 BR	AE 5/77 p. 44

FIGURE 5-1. BRAKES SUMMARY SHEET

5.2 BUMPERS

5.2.1 Subject Area

The information in this section contains data on front and rear bumper systems and soft front ends, including bumper reinforcements and the method of attaching the bumpers to the autos. Soft front ends (or facias as they're sometimes called) include the bumper, fender extensions, hood extensions, grille frame, and headlamp bezels composed of urethane or other plastic compounds.

5.2.2 Indexing Method

Since the worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to bumper technology and applications: BUMPER MANUFACTURER, AUTO MANUFACTURER, TOOLING, MATERIALS, WEIGHT REDUCTION, COST, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (origin source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on auto manufacturers who are considering chrome coate bumpers indicates that GM is planning to introduce this new application on some 1979 models. An innovative chrome sputtering system will be employed in the production process.

Worksheets pertaining to bumpers are found in Appendix B, Figure B-2.

5.2.3 Summaries

The summary sheet (Figure 5-2) included in this section consolidates the information presented in the worksheets according to materials and tooling used. It presents an overview of the status of each approach to manufacturing bumpers. It was derived from the worksheets by quick referencing under materials and tooling and incorporate the easy index system. Additional summary sheets can be prepared by quick referencing under supplier, auto manufacturer or any of the other column topics.

In addition, this section contains TABLE 5-2. SIGNIFICANT APPLICATIONS OF BUMPER SYSTEMS IN THE AUTOMOTIVE INDUSTRY, which lists historical and proposed applications of bumper systems.

TABLE 5-2. SIGNIFICANT APPLICATIONS OF BUMPER SYSTEMS IN THE AUTOMOTIVE INDUSTRY

MY	MFG.	
1968	GM	Pontiac GTO - Offered first soft front end in industry.
	GM	Pontiac Bonneville - Offered first soft rear end in industry.
1970	Ford	Mustang - First time Ford offered soft front end.
1973	Ford	Mustang - Offered soft front and rear ends.
1974	Ford	Ford and Lincoln/Mercury - Offered polygel mitigator energy absorbers (PGMs) on small cars.
1978	VW	Oasher - RIM polyurethane bumpers.
	GM	Chevy Monte Carlo and Grand AM - Guide-flex bumpers front and rear (soft painted plastic with aluminum reinforced bars).
	GM	Pontiac LeMans and Chevy Camaro - First industry use of one-piece all plastic front and rear ends.
	GM	Downsized Intermediates - (Chevy Chevette, Olds Cutlass, Buick Century, Buick Regal) Chrome plated HSLA steel back by aluminum reinforced bars on both front and rear bumpers.
1978	Chrysler	Plymouth Volare, Oodge Aspen - Chrome-plated HSLA steel on front and rear bumper face bars.
1978½	Chrysler	First company use of one-piece, HSLA steel bumper in recent years. Installed as mid-year change on front ends of all intermediate-size Plymouth Fury and Dodge Monaco.
1979	Chrysler	R Body - (Downsized standard size) - First industry use of chrome-plated aluminum bumpers.
	Ford	Panther Line - (Downsized standard size) - First industry use of chrome-plated aluminum bumpers. (On 1/5 of Panther line).
	Ford	Ford Model Line Station Wagons - 100,000 cars with extruded chrome-plated aluminum front bumpers and anodized rear.
	Ford	Mercury Station Wagon - 25,000 with chrome-plated aluminum rear bumpers and anodized front bumpers.
	Ford	Mustang III and Mercury Capri III Specialty Cars RIM soft urethane front end (2nd OEM user).

BUMPERS

SUMMARY SHEET

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BU page 1

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Polyester-reinforced rubber	2,500 ton injection molding machine	New bumpers involve in section molding of 11 different parts. Bumpers made in 3 sections: 3 for front, 5 for back. Sustain impacts of slightly more than 5 mph without damage.	USM Corp.	GM trucks	Advanced Design Bus (ADB)	Reduced			4 BU	AMM/MN 10/17/77 p. 5
PGM		Pressure tubes for poly-gel mitigator energy absorbers (PGMs). PGMs are bumper shock-absorbing devices designed to minimize collision damages in low-speed impacts. Fasten between bodies and bumpers.	Ford	Ford	'74 + MY Ford and Lincoln-Mercury small cars.				4 BU	AN 9/19/77 p. 43

FIGURE 5-2. BUMPERS SUMMARY SHEET

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
High yield strength anodized aluminum		Higher yield strength		Ford	'77 Pinto, Maverick '77 Mercury Bobcats '78 Granada, Monarch	Bumper 67 lb. less. Car 75 lb. less. 55% from 1976 models			4 BU	WAW 2/77 p. 12 AMM/MN 4/18/77 p. 41 AN 1977 Market Data Book p. 22
Aluminum		1st all aluminum bumper for Chrysler.		Chrysler	'78 Ply. Horizon '78 Dodge Omni				4 BU	WAW 10/77 p. 87
Aluminum		Sheet bumper reinforcements and brackets.	Reynolds	GM	'78 "B" body: Chevrolet, Olds, Buick, Cadillac, Pontiac '78 "A" body: Cutless, Grand Prix, Century, Monte Carlo, Chevelle				4 BU	WAW 10/77 p. 24
				Ford	'78 Granada, Monarch				4 BU	WAW 10/77 p. 24

FIGURE 5-2. BUMPERS SUMMARY SHEET (Continued)

BUMPERS

SUMMARY SHEET

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MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Urethanes Possibly with glass fillers	RIM	Development stage. Fenders that return to its original shape after impact could be produced in large scale within 3-4 yrs. Technology and machinery still lacking. GM and chemical companies studying effect of glass fillers on both properties of polymer and RIM process. Glass fillers add hardness, etc., and improves interface between Urethane and steel. May have problem with abrasion that use of glass filler creates in lines and tooling, and increased mold wear.	Union Carbide Owens Corning Fiberglass USM GM	GM					4 BU	WAR 10/3/77 p. 317

FIGURE 5-2. BUMPERS SUMMARY SHEET (Continued)

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Polyurethane backed by steel beams	RIM	Polyurethane bumper does not require additional energy conversion and reinforcement devices. Can be used as energy-absorbing elements for a 5-mph barrier impact.		VW	'78 VW Dasher	15% less than steel bumpers with hydraulic shock absorbers	Lower cost raw materials	More mpg.	4 BU	AE 10/77 p. 54 AMM/MN 10/3/77 p. 16
Chrome-coated plastic. Rigid ABS or soft thermoplastic urethane	Chrome Sputtering System	1st attempt for chrome-coated plastic bumpers by sputtering. Previously considered technologically impossible. Serious threat to bumper market for steel and alum. and conventional chrome plating. Testing sputtering chrome-plating on various parts and under numerous conditions, including impact. Conventional chrome-plating cracks under impact, partly because of pronounced differences between hardness of coating and bumper	Varian	GM	'79 models (specified models not indicated.)				4 BU	AMM/MN 10/24/77 p. 22

FIGURE 5-2. BUMPERS SUMMARY SHEET (Continued)

BUMPERS

SUMMARY SHEET

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BU page 5

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MOOEL	WEIGHT REOUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
One-piece all plastic		1st in industry -- soft front end and rear end.		GM	'78 Pontiac LeMans '78 Chevy Camaro				4 BU	AI 5/15/77 p. 13
Soft-painted plastic with aluminum reinforced bar, metal trim		Guide-flex bumpers front and rear.		GM	'78 Chevy Monte Carlo '78 Grand Am	100 lb. less than Monte Carlo			4 BU	AN 8/29/77 p. 3 AMM/MN 4/18/77 p. 41
Plastic fascia soft urethane front end	RIM (reaction injection molding) production: 5 clamping machines (or presses) & 1 chemical metering machine. lab: 1-2 presses	Utica, Mich. trim plant. Production and lab system for development future applications. Plastic fascia, unlike metal front and rear end system, will self-restore or recover from impacts and won't rust.		Ford	'79 MY Mustang III Mercury Capri III		Cost to Ford $700,000-1,000,000 for both systems		4 BU	AMM/MN 4/18/77 p. 16

FIGURE 5-2. BUMPERS SUMMARY SHEET (Continued)

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Nickel-chrome coated stamped aluminum. Alloy 7140, 7021, or 7029	Fabricated Alston 80 (with Cyanide) or	Ford: 100,000 cars with extruded chrome-plated front bumpers and anodized rear. Mercury: 25,000 with plated rear and anodized front bumpers		Ford	'79 Ford and Mercury Station Wagons.				4 BU	AMM/MN 5/23/77 p. 24 WAW 10/77 p. 87 WAW 5/77 p. 66 AMM/MN 7/4/77 p.1
	Alcoa 661 (w/o Cyanide)	Ford produced about 10,000 chromed alum. bumpers on pilot plating line in Monroe, Mich. 1st industry use - rear bumpers.	Ford	Ford	1/5 of '79 Panther line (smaller standard size.)				4 BU	AMM/MN 5/23/77
Urethane		Soft front.		Ford	'70 Mustang	Lowers wt.			4 BU	AI 5/15/77 p. 13
		Soft front & rear.			'73 Mustang					
Urethane		GM builds soft front end internally. 6% 1977 MY (industry wide) have soft front and/or rear. 12% 1978 MY, 30% MY 1980 projected by president of supplier co.		GM	'68 Pontiac GTO (first soft front) '68 Bonneville (soft rear) '73-'76 Laguna; '74 + Corvette; '74-'76 Grand Am. '72 + Firebird, '75 + Monza	Lowers wt.			4 BU	AI 5/15/77 p. 13

FIGURE 5-2. BUMPERS SUMMARY SHEET (Continued)

MATERIALS	TOOLING	BUMPERS	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Chrome-Plated High Strength Steel Face Bars	Stamped Plated	Front and rear bumper face bars. 55-60,000 psi range. Eliminate need for full-length reinforcement bars behind facings.		Chrysler	'78 Ply. Volare, Dodge Aspen	Considerable			4 BU	AMM/MN 6/27/77 p. 11
One-piece HSLA Steel Front Ends		One piece bumper used by Chrysler. Increase yield strength 100,000 psi. Lower fabrication and assembly costs. Forming dies are needed only for face bars. Do not need joining operations for assembly reinforcements to face bars.		Chrysler	'78½Fury -Monaco	23 lb./car (Old = 69 lb. New = 46 lb.)	Lower tooling cost		4 BU	AMM/MN 6/20/77 p. 14
Chrome-plated HSLA steel backed by aluminum reinforced bars. Alum. alloy 7046 or 7021 or 7106		Bumpers similar in design and makeup to all metal units on GM '77 MY standard cars. Both front and rear bumpers.		GM	Downsized intermediates. '78 Chevy Chevettes, Olds Cutlass, Buick Century Regal A Body.				4 BU	AMM/MN 6/20/77 p. 15
Nickel-Chrome coated stamped alum. Alloy 7140, 7021 or 7029.	Fabricated Alum Pretreat bumpers prior to plating-Alston 80 (uses Cyanide)	1st use of chrome-plated aluminum bumpers. Cost and technical difficulties until now have prevented chrome plated alum. bumpers from entering production use in U.S. Tested on 50 cars - Plymouth Fury, Gran Fury.	Houdaille Industries	Chrysler	'79 R body downsize standard models.	60-70% wt. reduction			4 BU	WAW 10/77 p. B7 WAW 5/77 p. 66 AMM/MN 7/4/77 p. 1 AMM/MN 5/23/77 p. 24

FIGURE 5-2. BUMPERS SUMMARY SHEET (Concluded)

5.3 CONTROL DEVICES

5.3.1 Subject Area

This section includes information on various automotive control devices, e.g., emission control devices, engine control devices, electronic vehicle control devices.

5.3.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to control device technology and applications: TYPE, SUPPLIER, AUTO MANUFACTURER, MODEL, COST, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs.

Worksheets pertaining to control devices are found in Appendix B, Figure B-3.

5.3.3 Summaries

The summary sheet (Figure 5-3) included in this section consolidates the information found in the worksheets. It presents an overview of the control device technology according to the type of control device. It was derived from the worksheets by quick referencing under type of device and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under auto manufacturer or any of the other column topics.

In addition, this section contains TABLE 5-3. TECHNOLOGICAL CHANGES IN AUTOMOTIVE CONTROL DEVICES, which lists historical and projected innovations for several types of electronic devices.

TABLE 5-3. TECHNOLOGICAL CHANGES IN AUTOMOTIVE CONTROL DEVICES

Vacuum Tubes	
1957:	Bendix fuel injection - first complex electronic unit in a production car.
Solid-State	
1960:	Diode rectifiers in Chrysler alternators - first use of an electronic device as a basic subsystem in the auto.
1972:	Solid State Chrysler ignition systems on some Chrysler engines.
1973:	Solid State ignition systems on all Chrysler V-8 engines.
1974:	Solid State ignition systems on all Chrysler auto engines.
Integrated Circuits	
1972:	Pontiac voltage regulator and unitized ignition built by General Motors is the first application of custom integrated circuits.
Analog Computers	
1976:	Standard on Cadillac Seville - Bosch and Bendix electronic fuel injection system.
	Black boxes used in closed-loop Lambda-sensing controls that make 3-way catalysts work. First marketed by Volvo and Saab.
	Chrysler lean-burn spark-adjustment system. 60,000 cars equipped, 99.9% reliability.
1978:	Chrysler lean-burn system on all 8-cylinder engines.
	Ford Pinto and Bobcats with automatic transmission for California market have closed-loop or feedback air/fuel ratio controls. Supplied by Motorola and Ford.
1978 (cont)	General Motors makes analog controls for air/fuel ratio controls (similar to Ford Control System) being fitted to some Buick-Olds-Pontiac subcompact models and also California models.
	General Motors spark control systems: 1. Turbo control center used by Buick in its turbocharged V-6 engines in Regal and LeSabre sport coupes have closed loop system - first in volume production. 2. Electronic spark selector used on Cadillac Sevilles (non-Diesel) have open loop design.
Combination Analog-Type Circuitry and Simple "Logic Chip"	
1974:	Seat belt-ignition interlock - first major electronic logic system used by total industry (short-lived)
1978:	General Motors Cadillac and Buick option - automatic level control for the rear suspension.
1978½:	Ford trucks have valve selector so use only half the number of cylinders during deceleration and idle.
Digital Microprocessor	
1977:	One application. Olds Toronado MISAR spark control system.
1978:	Five applications: 1. Olds MISAR system. 2. Ford electronic engine control (EEC I) on Lincoln Versaille. 3. Chrysler advanced solid-state search-tone radio. 4. Cadillac 1978½ Seville tripmaster. 5. Lincoln Continental Mark V miles-to-empty system.
1979 & 1980's:	Ford expects digital EFI control to be in production for 1979 model year and to be in wide use in 1980.

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CONTROL DEVICES

TYPE	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Electronically Controlled Engine Devices		Chrysler predicts 10% of cost of auto in 1985 will be electronic control devices. Company will introduce analyzer that can trouble-shoot 60 different engine functions in less than 4 minutes and supply printed information to mechanic telling him what to replace.		Chrysler	'78 MY			4 CD	WAR 8/8/77 p. 1
		Engine control electronic system - GM 1) Closed-loop fuel control; improved driveability at high altitudes. 2) Electronic spark control.		GM	'78 Caddy Seville			4 CD	WAR 9/26/77 p. 307
		3) Electronic spark selection in addition to an automatic level control.			Seville, Eldorado, Brougham, deVille (optional)				
		GM may never build a car with single microprocessor.							
		1) system would be more complicated than needed. 2) probably lack fail-safe features seen as key component in electronic design.							

FIGURE 5-3. CONTROL DEVICES SUMMARY SHEET

CONTROL DEVICES

SUMMARY SHEET

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TYPE	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Electronically Controlled Engine Devices		New electronic applications perform some jobs which simply could not be done without electronics.							
		Electronic Engine Control - Ford Plans to install in about 30,000 cars equipped with small V-8s during 1978 MY. Interactive system is controlled by digital microprocessor which adjusts both spark advance and exhaust gas recirculation.	Ford Electrical and Electronics Div.	Ford	'78 Versailles			4 CD	WEU 9/2/77 p. 2
			Tokyo Shibaura Electric Company					4 CO	AN 9/26/77 p. 8
			Essex Group of United Tech.					4 CO	AI 3/1/77 p. 18
		Lean Burn - Chrysler (Electronic Spark Advance) Lean-Burn meets federal pollution standards without need of catalytic converter and unleaded gas.		Chrysler	'76 Chrysler Cordoba 1st lean burn.			4 CO	AE 4/77 p. 24
		Lean burn on experimental 225 CIO 6-cylinder engine			Dodge Charger Experimental Car		Lean burn: 25.2 mpg highway, 17.4 city. Non-lean-burn	4 CO	MT 4/77 p. 20
							21 mpg highway 16 city.	4 CO	WAW 11/77 p. 31
		Lean Burn now available in all 8-cylinder engines. Expect 1 million purchased.		Chrysler	'78 MY			4 CO	AN 9/26/77 p. 8

FIGURE 5-3. CONTROL DEVICES SUMMARY SHEET (Continued)

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TYPE	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCE
Electronic Vehicle Control Devices		Tripmaster - GM 1st true high-performance computer ever offered for sale in autos. Designed initially to play on tasks not essential to safety car (digital instruments, fuel consumption indicators). Planned production 1978 = 20,000 units Seville production 1977 = 40,000 units.	GM	GM	'78 Caddy Seville		Expensive	4 CD	MT 10/77 p. 106
		New Applications - Ford Entertainment, vehicle control. Previously introduced features include anti-skidbrakes, speed control, ignition system, illuminated entry system and automatic headlight control.		Ford	'78 Versailles, '78 Lincoln Continental Mark V			4 CD	AN 9/26/77 P. 8
		Electonically-triggered Voice Messages FSW developing instrument panel that will inform drivers about as many as 27 different diagnostic problems as they occur. 1st application of voice system was GM's Computer Recall Identification System (CRIS) used by dealers to learn what safety recall campaigns a particular car was involved in.	Federal Screw Works	GM Ford			8 x what auto mfg. will pay.	4 CD	AI 5/1/77 p.7
Electronic Vehicle Control Devices		Production in 1977 - Chrysler 400,000 spark computers 300,000 digital clocks 2,000,000 electronic ignition units (Huntsville, Ala. plant.)		Chrysler	1977 MY			4 CD	WAR 10/17/77 p. 331

FIGURE 5-3. CONTROL DEVICES SUMMARY SHEET (Continued)

CONTROL DEVICES

SUMMARY SHEET

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CO page 4

TYPE	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Emission Control		Catalytic Converter 2 sections: 1) forward part: 3-way oxidation/reduction catalyst. 2) farther part: conventional oxidation unit.		Ford	'78 Fairmont Zephyr			4 CO	WEU 9/2/77 p. 3
		Must maintain air/fuel ratio at 14.7:1 (±.05)---need electronic sensors since mechanical systems affected by too many variables.		Chrysler					
		Tradeoffs between fuel economy standards, and safety and service law and regulations that hurt fuel economy.						4 CD	AN 8/29/77 p. 8
		1981 standards will bring a closed-loop fuel control system and electronic engine controls, along with a dual converter system.		GM		Car $25 and up by 1980. Additional $140-160 in 1981.		4 CO	WAR 8/29/77 p. 275
	Aluminum, steel, iron.	Air Injection pumps Will be used further in 1980s, probably in combination with electronically controlled carburetors or fuel injection systems and 3-way catalytic converters to meet stiffer regulations.		GM	California model Caddy Seville			4 CO	AMM/MN 10/24/77 p. 13
		Emission controls must last 5 years or 50,000 miles with proper maintenance; sealed electronic units better for auto mfg.							

FIGURE 5-3. CONTROL DEVICES SUMMARY SHEET (Concluded)

5.4 ELECTRICAL SYSTEM

5.4.1 Subject Area

This section includes information on the automobile's electrical system, e.g., battery, lights, ignition system.

5.4.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to electrical system technology and applications: COMPONENT, MATERIALS, SUPPLIER, AUTOMOBILE MANUFACTURER, MODELS, WEIGHT REDUCTION, COST, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on suppliers who are involved with lights innovations indicates that Dupont's fiber optics are already being used on some trucks.

Worksheets pertaining to the electrical system are found in Appendix B, Figure B-4.

5.4.3 Summaries

The summary sheet (Figure 5-4) included in this section consolidates the information found in the worksheets. It presents an overview of technological improvements in electrical system components. It was derived from the worksheets by quick referencing under components and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under other column topics.

In addition, this section includes TABLE 5-4. SIGNIFICANT APPLICATIONS OF AUTOMOTIVE ELECTRICAL SYSTEMS, which present historical, current, and projected applications of new technology concerning electrical system development.

TABLE 5-4. SIGNIFICANT APPLICATIONS OF AUTOMOTIVE ELECTRICAL SYSTEMS

Mid-1960's	Chrysler was first OEM to use EPDM-insulation plus silicone jacket combination cable in electronic ignition package.
Mid-late 1960's	GM used EPDM/silicon cable on their HEI system.
Late 1960's	Silicone rubber spark plugs became standard equipment.
1975	Ford began using a total silicone insulated cable on some models.
1977	GM uses fiber optics in dashboard of some GM heavy duty trucks.
1978	Ford uses Lead-strontium alloys in Versaille battery to gain reliability in production.

ELECTRICAL SYSTEM

SUMMARY SHEET

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ES page 1

COMPONENT	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCE
Battery for Electric Cars		Battery research going on as prelude to Electric Car.						4 ES	MT 10/77 p. 17
		Over 400 electric vehicles: U.S. Postal Service carts, golf carts, electric taxis in England.		AMC					
	Zinc-Nickel oxides	Testing		GM					
	Lithium-ion Sulfide								
	Zinc-Chlorine. Sodium-Sulfur. Lithium-metal sulfurs	Expects share electric cars to be 10% in 15-20 years.	Gulf-Western, Hooker Chemical			Weighs 800 lbs.			
		Tested car with 20 diehards and one for accessories. Removed radiator, gas tank, gas lines.	Sears			100 lb. more.			

FIGURE 5-4. ELECTRICAL SYSTEM SUMMARY SHEET

ELECTRICAL SYSTEM

SUMMARY SHEET

COMPONENT	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCE
Lights	Fiber optics: Dupont Crofon	Fiber optics is a method of illuminating small areas in cars (such as switches on dashboard). Using ribbon fiber optic system, up to 6 different paths can be illuminated from one bulb. Light can be bent, twisted, etc., with little effect on light being transmitted. Advantage to eliminate size and heat of bulbs in small areas especially among delicate electronic components.	Dupont Packard Electric Div. of GM	GM Heavy duty trucks	GMC trucks		Cost Advantage	4 ES	AI 2/1/77 p. 49
Automotive Ignition Cable	See list attached	New materials needed which can withstand higher temperatures raised by new electronic ignition devices, engine controls, power options. Particular increase in use of silicone cable in high temperature areas including silicone rubber spark plugs which became standard equipment in mid-late '60s.					Silicone sets initially cost more but overall performance superior.	4 ES	AI 1/1/77 p. 34
		Electronic ignition package first OEM use of EPDM-insulation-plus silicone jacket combination cable.		Chrysler	Mid '60s				
		HEI system used EPDM/silicon cable.		GM	Mid-late '60s				
		Total silicone insulated cable.		Ford	Some '75 MY 1976 and 1977				
Battery Improvements	Lead-Strontium Alloys	Advantage claimed is reliability in production which has helped control production costs and hold prices at present levels	Globe-Union	Ford	'78 Lincoln-Mercury Versailles			4 ES	WEU 7/22/77 p. 6
	Silver-Iron	Pilot scale production of battery which offers highest energy density per pound of any battery available.	Westinghouse Electric Co.					4 ES	AMM/MN 10/24/77 p. 2

FIGURE 5-4. ELECTRICAL SYSTEM SUMMARY SHEET (Concluded)

5.5 ENGINE, DRIVE-TRAIN PARTS

5.5.1 Subject Area

This section includes information on engine and drive-train parts, e.g., carburetor, transmission, driveline, axles and engine components such as cylinder block and head, manifolds, spark plugs.

5.5.2 Indexing Method

Since the worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to engine and drive-train parts: COMPONENT, MATERIALS, TOOLING, SUPPLIER, AUTOMOTIVE MANUFACTURER, MODEL, WEIGHT REDUCTION, COST, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for information which is most relevant to his current needs.

Worksheets pertaining to engine, drive-train parts are found in Appendix B, Figure B-5.

5.5.3 Summaries

The summary sheet (Figure 5-5) included in this section consolidates the information found in the worksheets and present an overview of changes being made in engine and drive-train parts. The summary was derived from the worksheets by quick referencing under component and incorporates the easy index system. Additional summaries can be prepared by quick referencing under other column topics.

In addition, TABLE 5-5. SIGNIFICANT DEVELOPMENTS IN THE USAGE OF AUTOMOTIVE ENGINE AND DRIVE-TRAIN PARTS, lists historical and projected applications of new and innovative engine and drive-train parts.

TABLE 5-5. SIGNIFICANT DEVELOPMENTS IN THE USAGE OF AUTOMOTIVE ENGINE AND DRIVETRAIN PARTS

MY	MFG.	
Jan. 1977	GM	Offered cast iron ring and pinion gears on rear axle as standard equipment on all full-size station wagons. First use in auto industry.
1977	GM	Olds Toronado used HY-VO (high velocity) front wheel drive chain.
	GM	Discontinued 4-cylinder aluminum engine and Vega line.
1978	GM	Olds 88, 98 offered first diesel for passenger car by U.S. manufacturer as option.
	Ford	Designed smaller rear axles for Fairmont and Zephyr.
	Ford	Aluminum replaces cast-iron intake manifolds in V-8 engines for Granada and Monarch. First time for Ford.
	Chrysler	First industry use of 2-piece aluminum intake manifold produced using electron beam welding rather than laser welding or mechanical fastening techniques. Used in Plymouth Volare and Dodge Aspen.
	Chrysler	One-piece aluminum intake manifolds in V-6 engines.
1978	GM	Buick Regal Coupe and LeSabre Sports Coupe are first in industry to use even-firing V-6 turbocharger engine.
	Chrysler	Plymouth Horizon and Dodge Omni have front wheel drive.
1979	GM	Compacts will have front wheel drive.
	Ford	Plans production of stamped (instead of cast) steel rocker arms.
	Ford	Redesigning smaller rear axle for downsized standard models, compacts, station wagons.
1980	Chrysler	Plans to offer optional aluminum cylinder block in some V-8 engines.
Early 1980's	Ford	Plans production of 2-piece aluminum intake manifold produced with electron beam or laser welding.

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COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Rear Axles			Redesigned 6.75 in axle		Ford	'79 Mustang III, Capri IV, Pinto, Bobcat.				4 ED	WEU 6/10/77 p. 1
			Optional 8.5 inch replace 9 inch.		Ford	'79 LTD, Marquis Station Wagons					
			Spin-resistant differential (SRD) uses lighter 7½ inch axles instead of 8½ inch axle.	Warner Gear	GM					4 ED	AI 7/1/77 p. 33
	Iron	Cast	Cast iron ring and pinion gear are comparable to steel gears in durability. Initial annual production expected to be 1.1 million sets.		GM	Jan. 1977 Standard Equipment all GM full-size station wagons, most Cadillacs, some Buick Rivieras, other full size.	2 lbs. on Pontiac.			4 ED	WAR 10/17/77 p. 331

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 2

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
	Cast-Iron Case		T-10, 4-speed, manual transmission	Warner Gear	GM	'57 Chevy Corvette (debut)	85 lbs.			4 ED	AI 7/1/77 p. 33
	Aluminum Case		T-10, 4-speed, manual transmission	Warner Gear	GM	'77 Chevy Corvette, Z-28 Camaro, Pontiac Trans AM	70 lbs.				
Driveshaft leaf spring	Graphite fiber composites		Leaf spring has same spring rate and load capacity		Ford	'76 Granada	84% on leaf spring (fiber = 4.5 lbs. steel = 28 lbs.)			4 ED	AI 7/1/77 p. 33
Driveshaft Suspension Gear; push rods; bearings; transmission supports; driveshaft yokes	"Magnamite" made from polyacrylonitrite (Type AS-3)		Cost effective structural material with high stiffness, low weight, and versatility of fabrication. Best applications are where the filament on continuous form can be used.	Hercules, Inc.			Reduction in each component compared to steel - fiber = 70%+ plastic =50% AL=4D-50% HSLA steel = 10-30%		$18/lb. raw material (previously $32/lb. Anticipate $1D/lb.		
Rear Axles			Axles lighter and more efficient.								
			7.5 inch replace 8 inch expanding production facilities in Michigan.	LaSalle Machine Tool Inc.	Ford	'78 Fairmont/ Zephyr compacts	9-28 lbs. per car.		Tooling Cost $50-100 million	4 ED	WAR 9/26/77 p. 308
			7.5 inch replace 8 inch (different dimensions and characteristics than compact)	Cross Co. Apex Corp. Bendix Machine Tool Company	Ford	'79 down-sized standard LTD, Marquis	Lighter			4 ED	WEU 6/10/77 p. 1

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 3

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT ~~REDUCTION~~	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
			and sprockets.				Single Assembly = 69 lbs. 2 speed = 105 lbs.			4 ED	R&T 11/77 p. 45
Transmission		Cold Extrusion Techniques in place of hobbing, pot broaching or any other chip-forming operation	Developed new technique for roughing out transmission helical gears. Plan to produce on pilot line in 1979 on forthcoming FIOD (Ford Integral Overdrive) automatic transmission manufacturing program. Higher production capacity.		Ford				Use less energy, less floor space, reduce overall tooling costs.	4 ED	AMM/MN 10/3/77 P. 1
			Increased demand for manual transmission T-50 transmission manual	Warner Gear	GM	'77 Chevy, Buick, Olds, Pontiac				4 ED	AI 7/1/77 p. 33
	Aluminum Case		151 cu. in., 4-cylinder, automatic transmission			'77 Pontiac Astre	93 lb. case	27 mpg combined 32 highway			
	Aluminum Case		T-50, 5-speed overdrive, manual transmission			'77 Pontiac Astre	65 lb. case	33 mpg combined 41 highway			
	Aluminum Case		SR-4, 4-speed, manual transmission	Warner Gear	Ford	'74 + Mustang II compact.	58 lb. case				
			SR-4, 4-speed optional transmission vs. 3-speed		AMC	Pacer, Hornet, Gremlin	20 lb. less				

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 4

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Rotary Engine			Discontinued research and development on rotary engine primarily because rotary engines couldn't achieve low emission levels and fuel economy of current engines.		GM					4 ED	AI 5/15/77, p. 11
			Markets 3 types of engines: rotary, conventional piston, diesel.		Mazda			32 mpg highway 20 mpg city			
Front Wheel Drive			FWD cars designed to maximize the benefits of driving the front wheels						Tooling costs high if convert from rear drive. Comparable if mfg. from scratch.	4 ED	AI 7/1/77 p. 33
			Use of FWD may depend on size -- FWD on smallest and mid-range cars, rear drive for larger cars		Fiat					4 ED	R&T 11/77 p. 45
			US mfg. shifting to FWD beginning with compacts → may be beginning of trend to complete FWD.		GM	'79 MY compacts					
					Chrysler	'78 sub-compacts Plymouth Horizon, Dodge Omni.					
			New Chains Quadra-trac two-sp ed/four-speed drive transfer case (option)	Warner Gear	AMC	Jeeps	new=100 lbs. old=210 lbs. (cast iron)				
			Hy-Vo (high velocity) chain. Smaller size. When engine mounted transverse or longitudinal, most efficient way of coupling engine/transmission is to couple output shaft of engine to input shaft of transmission via high-speed chain	Morse Chain	GM	'77 Olds Tornado	Chain 30% less. new =4.8 lb. old =6.8 lb. chain driven transfer case				

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 5

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT ~~REDUCTION~~	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Diesel Engine	Conventional metals for all parts except camshaft and hydraulic lifters		Modifying 350 CID V-8 engine to perform like diesel -- performance about same as 260 CID V-8 gas engine. Extra equipment includes 2 batteries, fuel injection, injectors, glow plugs and various associated components but no catalytic converter. Compression ratio increased to 22.5:1. Olds needs 7 quarts of oil instead of 5 and changings every 3,000 miles. May have problem with emission of NO_x if 1978 standards lower since engine operates at higher temp -- increased NO_x.	GM	GM	'78 Olds Chevy and GMC trucks	130-180 lbs. increase (includes extra equipment) over gas 350 V-8	25% increase diesel: highway=29 city = 20 350 V-8 gas highway=21 city = 16	$700-$900 more per Olds.	4 ED 4 ED 4 ED 4 ED	MT 10/77 p. 84 R&T 11/77 p. 63 WEU 9/16/77 p. 4 MT 5/77 p. 19
				Nissan	Chrysler	'78 trucks					
				Peugot	Ford	'78 Granada in Europe					
					AMC	'78 Jeep Overseas					
Diesel Engine			Computer simulation of hypothetical diesel engine AD-209 featuring variable compression ratio and exhaust turbocharging. Simulate for mileage and emissions. No engine built. Results of computer simulation	Teledyne Continental Motors with ERDA support			Wt.=495 lbs. (include fan, starter, alternator) 3000 lb. car. 3400 lb. car. 3700 lb. car.	 30.3 mpg. 29.1 mpg. 28.3 mpg.		4 ED	AE 7/77 p. 40

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECON.	COST	MEDIA REF. BOOK NO.	REFERENCES
Intake Manifolds	Aluminum	Electron Beam or Laser Welding	Developing a single plane manifold which can be split in 2 pieces (instead of 4 or 5) and joined by welding. Could be ready for production in early 1980s.		Ford		2 - 3 lbs.		Cost effective	4 ED	AMM/MN 6/13/77 p. 37 AMM/MN 2/21/77 P. 4
Intake Manifolds	Aluminum Alloy 380	Two-piece die-cast manifolds or one-piece mold-casting or one-piece sand casting	Two-piece, die cast manifolds assembled with electron beam welders for Volare/Aspen. Other new aluminum intakes for '78 models will be 1st 1-piece units made by permanent mold casting or sand casting - no welding or joining process will be required. Long range plans to convert 8-cylinder engine manifolds from cast iron to aluminum.	Leybold-Heracus Vacuum Systems Inc. Allen-Bradley Co. (equipment)	Chrysler	'78 Plymouth Volare, Dodge Aspen. '78 MY V-6 engines	12 lbs. less on 4-door Volare/Aspen than cast iron (2/3 lighter than cast iron units)		Die-casting more economical tooling	4 ED 4 ED	WEU 9/16/77 p. 3 AMM/MN 7/18/77 p. 12
Intake Manifolds	Aluminum		Previously used in Chevy V-8s, especially LT-1/Z-28 special high performance 350 4-V, L-88 427-4V, and a few 454-4V V-8 engines (primarily Corvette and Camaro.)		GM					4 ED	WAW 2/77 p. 13
	Zinc		Studying ways to maintain and expand use of zinc in autos. Possible long-term uses include: 1) super-plastic zinc in fuel in fuel-injection system. 2) new alloy ILZRO 16 for moving parts under hood	Pioneer Engineering & Mfg. (researchers)						4 ED	AMM/MN 5/23/77 p. 25

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 7

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECON.	COST	MEDIA REF. BOOK NO.	REFERENCES
Carburetor			V.P. Bendix Corp. predicts end nearing for standard carburetor as demand for precise fuel metering increases.	Bendix Corp.						4 ED	WAW 8/77 p. 25
			By 1981, Bendix will market system consisting of sensors, actuators, fuel injectors and central electronic "brain", with digital electronics in central computer and single point ignition.			1981			Under $100		
			Single point injection ready.			1979 MY			Lower than 4,6,8 nozzles.		
Intake Manifolds	Aluminum	Low Pressure Casting and Gravity Permanent mold casting	1st time for Ford, who will install on about 50,000 V-8 engines.		Ford	'78 Granada, Monarch	30 lbs. less (Alum = 15 lbs. Cast Iron = 45 lbs.)			4 ED 4 ED	AMM/MN 8/29/77 p. 18 AMM/MN 4/25/77 p. 13

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS

SUMMARY SHEET

CTP - MCI 11/22/77

ED p.8

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT. RED	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Spark Plug	Currently 78-90% nickel in each electrode		Suppliers want change in electrode metals to reduce cost and dependence on nickel-rich alloys. Change would require EPA certification because spark plug is considered part of emissions control system.	Bendex Corp. GM AC Spark Plug Div.						4 ED	AMM/MN 8/22/7 p. 21
	Platinum-Gold Electrode Plug		Largest V-8 engines.	Champion	Chrysler	1975 models			$6 Platinum-Gold (vs $1.25 nickel) lasted twice as long.		
	Iron Alloys	Easier to form and weld							Less costly.		
	Tungsten and Tungsten-Carbide		High temperature materials used in plasma jet spark plug in development stage. Would require different electrical system.	Bendex Associated Eng (Britain)	Ford			Use lean-fuel mixture to save gas.	Costly	4 ED	AMM/MN B/15/77 p. 5

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p. 9

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
V-6 Engine			New 200 cu. in. V-6, 90 degree engine 8 inches shorter in length than 250 cu. inch inline 6.		GM	'78 Chevy Malibu	63 lbs. less than '77 MY	14% increase in mpg.		4 ED	WEU 9/16/77 p. 4
			Redesign V-6		GM	'78 Chevy ElCamino pickup	600 lbs. per car. 80 lbs. less per engine.	Improved		4 ED	AN 10/3/77 p. 8
			Turbocharger; even-firing. Can increase air/fuel mixture for acceleration, yet run at high economy consumption rates during normal driving.		GM	'78 Buick Regal Coupe, LeSabre Sports Coupe.		Increase mpg.			
4-Cylinder Engine	Aluminum Blocks and Cylinders	Die Cast Blocks	Discontinued aluminum engine and Vega line due to problems in design, endurance, short life, overheating.		GM	Chevy Vega, Monza, Pontiac Astre, Sunbird.	Engine weight = 330 lbs.			4 ED	WEU 9/16/77 p. 5

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS

SUMMARY SHEET

CTP - MCI 11/22/77

ED p.10

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT RED.	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Bell Housing	Steel	3-stage stamping	Sheet steel bell housing. No machining, minor grinding only.	U. S.Steel			Stamped steel = 35 lbs. Cast iron = 49 lbs.		Production costs reduced	4 ED	AI 7/1/77 p. 33
Rocker Arms	Steel. Studying Ceramics and high-performance carbon fiber reinforced plastic.	Stamped instead of cast	Production scheduled in Cleveland plant 1979 or 1980 for stamped steel rocker arms.		Ford		Lighter weight		Steel less costly than Carbon-fiber units.	4 ED	WEU 9/16/77 p. 3

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p.11

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT. RED.	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
Cylinder Block	Aluminum	Less machining. die casting. mold casting.	Phasing in aluminum over next 10 years. By 1985, Ford expects aluminum consumption to double: 110 lbs./car (3%) to 200-250 lbs./car (6-8%). But design constraints with aluminum die castings make it more practical in short run to initially produce components as low pressure, semi-permanent mold castings.		Ford		Save 25-30 lbs. per cylinder over cast iron.		Lower capital investment	4 ED	AMM/MN 6/13/77 p. 37
Cylinder Blocks, Exhaust Manifolds	Thinner Gauge Cast Iron		Next 3-4 years, Chrysler will substitute aluminum and thinner-gauge cast iron in engine parts. Engine package includes single-barrel carburetor, cast iron head, manifolds, torque converters.		Chrysler					4 ED	WEU 6/10/77 p. 1
Intake Manifolds	Aluminum						318 CID V-8 cylinder reduced 70-120 lbs. from 614 lbs.				
Cylinder Block	Aluminum		Optional by 1980		Chrysler		318 CID V-8 cylinder 50 lbs. less				
Cylinder Block	Aluminum High Silicon Alloy 390	Reynolds Technique for Chevy Vega	Light-alloy water-cooled V-8 has ideal 50:50 front/rear weight distribution.	Reynolds	Porsche	928	Dry engine, radiator accessories weigh 200 lbs. less than U.S. iron V-8			4 ED	AE 6/77 p. 17
Pistons	Aluminum Coated with Steel	Chevy Vega	Cylinder block not need cast iron-liners.		Mercedes Benz	450 SLC Coupe				4 ED	WEU 6/10/77 p. 8
Crank-shaft	Steel	Forged	Fuel injection and electronic ignition in engine.							4 ED	WAR 10/3/77 P. 317
Bearing Caps	Aluminum	One piece Casting									

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Continued)

ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET CTP - MCI 11/22/77 ED p.12

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WT. RED.	FUEL ECONOMY	COST	MEDIA REF. BOOK NO.	REFERENCES
	Aluminum HSLA steel (steel with traces columbium and vanadium)		Chrysler engineer Winders "There's a fixed relationship between overall vehicle weight and drive-line weight. The curve of that relationship is pretty flat". Effort to reduce both sprung and unsprung weight - as in wheels. See attached list for Chrysler Chassis Weight Savings through Material Substitution.		Chrysler					4 ED	AI 7/1/77 ·p. 33
V-8 Engine			Ford expanding production of V-8 302-cu. in. engines in Cleveland plant. Engines will replace 351, 400, 460 CID V-8s.	Wilson Automotive, Automatic Production Systems, Visi-trol Engineering Company	Ford	'79 MY Standard cars. '76+ intermediate cars. Optional on smaller cars.			$10 million assembly line	4 ED	AMM/MN 2/21/77 P. 4
	Iron, steel, aluminum	Castings Forgings	Traditional methods. Engine is heaviest component of drive-train. Factors affecting weight are controlled by design, materials, manufacturing processes and cost.								
Cylinder Block			In engine design, important to pay critical attention to major components - particularly cylinder block - since other components, such as intake and exhaust manifolds, and water pump proportionately relative. Analysis reveals many areas in block from which nonfunctional material can be removed. Thin walled castings produced with interlocking cores.				3.0 lb. per block			4 ED	AI 7/1/77 p. 33

FIGURE 5-5. ENGINE AND DRIVE-TRAIN PARTS SUMMARY SHEET (Concluded)

5.6 FASTENERS

5.6.1 Subject Area

This section includes information on mechanical fastening systems used in the automotive industry. Adhesives are included under materials in Sections 4.2 of this volume.

5.6.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to fastener technology and applications: SUPPLIER, AUTO MANUFACTURER, MATERIALS, COST, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs.

Worksheets pertaining to fasteners are found in Appendix B, Figure B-6.

5.6.3 Summaries

Two tables present an overview of significant trends in the development and use of fasteners in automobiles:

TABLE 5-6. SIGNIFICANT TRENDS IN THE USE OF AUTOMOTIVE FASTENERS, lists historical and projected applications of fasteners in automobiles.

TABLE 5-7. MANUFACTURING PROCESSES AFFECTING FASTENER USE IN THE AUTOMOTIVE INDUSTRY, describes current and experimental processes available to manufacturers.

TABLE 5-6. SIGNIFICANT TRENDS IN THE USE OF AUTOMOTIVE FASTENERS

SYSTEMS APPROACH TO DESIGN	Today's higher quality and more cost effective fastening of automotive components is a result of better coordination between auto manufacturers, fastener suppliers and tool suppliers.
EFFECT OF DOWNSIZING CARS	Joint design (which is done by auto manufacturers) is most critical since it may be possible to reduce the size of bolts but not the number of bolts needed for a given joint design. Smaller cars will probably need fewer, lighter (and sometimes smaller) fasteners. Bolt makers, who are concerned with weight reduction of bolts, see the problem as upgrading the strength of a bolt so a smaller bolt can be used rather than redesigning the current styles. Ford redesigned the hex head flange bolt to have smaller mass while increasing its strength. Although not in production as of May 1977, it could save 2,000 tons of metal each year. Toolmakers are not really affected by downsizing since tension settings stay the same and torque settings can be recalibrated. Automakers feel downsizing of fasteners by itself is not as important as lightening other components as a result of lighter fasteners. A weight savings of 50 lb. on fasteners is much more expensive to achieve than other weight reduction techniques.
STANDARDIZATION OF FASTENERS	Chrysler's fastener standardization program since 1974 has cut down the different types of fasteners used by 20%. However, changes to front-wheel drive design necessitate changes in fastener design, so further standardization probably would not be promoted until new powertrain layouts are established.
CHARACTERISTICS	Efforts to make fasteners corrosion resistant have resulted in better coatings. Poor quality and application of coatings could lead to problems of finish buildup, distorted dimensions and possible torquing problems or snapping of bolts. Materials such as boron, high carbon spring steel, stainless steel, more aluminum, and zinc platings have been suggested for use against corrosion.
ALTERNATIVES TO MECHANICAL FASTENING	Adhesives and welds are not compatible with mechanical fasteners since adhesives and welds can be used for permanently sealed components but cannot be used for parts which must be serviced. Rivets occupy the middle ground - not permanent like welding but not easily removable like a nut and bolt. It's estimated that General Motors downsizing program for 1978 will require an additional 100 million blind rivets over previous years. Sometimes mechanical fasteners and adhesives are used together. When fasteners coated with adhesive capsules are applied, some of the capsules break and bond, giving a secure fit. Fasteners can be removed several times before the adhesive is used up. This is becoming popular in interior trim application where the fastener is going through plastic. See Adhesives section 3.2 in this volume for further information.

TABLE 5-7. MANUFACTURING PROCESSES AFFECTING FASTENER USE IN THE AUTOMOTIVE INDUSTRY

Precise measurement of the clamping force of mechanical fasteners is necessary in order to maximize the effectiveness of each bolt.

A fastener clamps a joint together by tension (the stretching of the fastener which takes place when the fastener is tightened). Until recently, however, no technique existed to measure tension directly so torque (a measurement of the turning force applied to an object) is measured as an approximation of tension. This results in errors of ±30% of the clamping force desired. When fasteners are tightened to 30% below the desired tension, additional fasteners may be needed to join the parts. Fasteners tightened to 30% above the desired tension may pass their yield point, snap and require expensive rework. Thus, values for clamping are usually set well below the yield point with effective joints made by using either a larger fastener or more fasteners-neither of which is acceptable for small, cost-sensitive cars.

As of 1977, there are four experimental systems made by SPS, Ingersoll-Rand, Atlas-Copco and Thor Division of Stewart-Warner which measure tension directly using new electronic fastening tools. General Motors has one system which cost $15,000 and uses it for structural, not decorative, fasteners.

Use of such systems is expected to increase in the near future particularly in response to the standardization of fasteners and an anticipated reduction in the number of fasteners to be used in smaller cars.

5.7 MAJOR BODY PARTS

5.7.1 Subject Area

This section includes information on major body parts, e.g., frames, body panels, doors, hoods, decklids.

5.7.2 Indexing Method

Since the worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information most relevant to the technology and applications of major body parts: COMPONENT, MATERIALS, TOOLING, SUPPLIER, AUTOMOBILE MANUFACTURER, MODEL, WEIGHT REDUCTION, COST, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs.

Worksheets pertaining to major body parts are found in Appendix B, Figure B-7.

5.7.3 Summaries

The summary sheet (Figure 5-6) included in this section consolidates information presented in the worksheets and presents an overview of the technology concerning various major body parts. It was derived from the worksheets by quick referencing under component and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under other column topics.

In addition, this section includes TABLE 5-7. SIGNIFICANT DEVELOPMENTS CONCERNING MAJOR BODY PARTS IN AUTOMOBILES, which lists historical and projected developments impacting on major body parts.

TABLE 5-8. SIGNIFICANT DEVELOPMENTS CONCERNING MAJOR BODY PARTS IN AUTOMOBILES

	Auto Mfg.		Body Part
1977		First industry use of aluminum hoods.	Hoods
	GM	Aluminum hoods on some Olds 88 (supplied by Alcoa) and Cadillacs (supplied by Reynolds).	
	Ford	Aluminum hoods on some Lincoln-Versailles (supplied by Reynolds).	
		Media reported Owen-Corning fiberglass (reinforced plastic) door weighing about 43% less than comparable steel could be produced in volumes up to 1.2 million annually.	Door
	AMC	Pacer uses 38 lbs. of ABS plastic in 70 parts. Average car uses 16-21 lbs.	
1978	GM	First industry use of aluminum deck lids on Chevy Monte Carlo and Buick Regals with extra options.	Deck Lids
	GM	Stamped one-piece HSLA steel door beams replace roll-formed HSLA steel beams.	Door beams
	Ford	Steel side door impact beams on Fairmont and Zephyr	Door beams
	Ford	Fairmont and Zephyr have HSLA steel 980XK frame which replaces plain carbon steel.	Frame
	GM	First industry use on Chevy Malibu, Malibu Classic and Monte Carlo of one piece glass fiber-reinforced polyester front header panels which are coated with special polyurethane primer (by Sherwin Williams) which gives attractive finish. Panels include hood extension, grille surrounds and fender extensions.	Panels
		Reported in media that General Tire and Rubber is working on some advanced primers that can be applied to plastic parts while they are still in the molds of the forming machines. Possible applications include body panels.	
	GM	Chevy and Buick downsized intermediates have plastic fender liners.	Fender liners
	GM	Chevy Corvette reported to have plastic rear end moldings made of glass fiber-reinforced sheet molding compounds.	Rear end
1980-81		Use of ABS plastic expected to reach 26-28 lbs./vehicle. Possible applications include instrument panels, sideview mirrors, door handles, wheel covers, headlamp doors, grille surrounds, seats.	

MAJOR BODY PARTS SUMMARY SHEET

CTP - MCI 11/22/77 BP p. 1

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Frame			Fork-type frame provides more controlled deformation of the front end to improve crash-worthiness.		Audi	'78 Audi 5000	Reduced weight		4 BP	WAR 8/1/77 p. 245
			Experimental diesel car also has fork-type frame which would protect occupants from frontal collisions up to 40 mph.	VW	VW					
Frame			Downsized to wheelbase 108 inch but keep full-frame construction of car 114 inch wheelbase and larger.		GM	'78 Inter-mediates (A-body)	Cars 550-980 lbs. less than '77 models		4 BP	WAR 7/18/77 p. 229
			See attached list for U.S. cars by Body/Frame type.							
Small areas unpainted	ABS (acrylonitrite butadienestyreno) Family of 15 plastics.		Possible applications: instrument panels, sideview mirrors, car door handles, wheel covers, headlamp doors, grille surrounds, structural seat	Borg-Warner Chemicals		'77 Models	16-21 lb. ABS		4 BP	AN 5/30/77 p. 8
			1980-81 use ABS 26-28 lb./vehicle as opposed to 21-22 lb. originally forecast. Not replace sheet metal because no plastic can withstand heat treating of paints.		AMC	Pacer	38 lbs. ABS in 70 parts.			

FIGURE 5-6. MAJOR BODY PARTS SUMMARY SHEET

MAJOR BODY PARTS SUMMARY SHEET CTP - MCI 11/22/77 BP p.2

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Fender Liners	Plastic: ex-reinforced polypropylene copolymer	Injection molding machines	Plastic fender liners replace steel and have benefits in terms of weight and corrosion-resistance.	GM manufacturer fenders Material and chemical suppliers: Thermofil, Inc.; Dart Ind.	GM	'78 downsized intermediate cars. Chevy Malibu, Monte Carlo. Buick Century, Regal	About 10 lbs./car saved. Fenders weigh about 7 lbs. ea.		4 BP	AMM/MN 8/1/77 p. 5
	Steel		Continue with steel liners with superior strength, flutter-resistance, durability. Expect at least 2-million plastic units molded. Steel manufacturers disappointed.	Hercules, Inc.; Owens-Corning	GM	Pontiac				
	Thermoplastic	Stamped		Ford	Ford	'78 light duty trucks series "F"				
Frame	HSLA steel 980XK	Reduced welding operations.	HSLA substituted for plain carbon steel in similar way as '77 AMC Gremlin and Hornet.	Ford	Ford	'78 Fairmont/ Zephyr	3.44 lb/ car in sill area	Reduced: fewer parts, less tooling investment.	4 BP	AMM/MN 6/27/77 p. 11

FIGURE 5-6. MAJOR BODY PARTS SUMMARY SHEET (Continued)

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Body Panels	Polyurethane primer for coating plastic parts	Compression molding machines make one-piece panels which are coated prior to assembly on car.	1st polyurethane primer to be used on major body parts good enough to cover imperfections and economically feasible panels contain hood extension, grille surrounds and fender extensions.	Sherwin-Williams Co. (primer)	GM	'78 Chevy Intermediate size	Malibu 550-972 lbs. lighter than '77 year.		4 BP	AMM/MN 7/25/77 p. 1
						Malibu	7 lbs. less than metal assemblies			
	Panels made from glass fiber reinforced polyester.					Monte Carlo	12 lbs. less than metal.			
			Working on advanced primers that can be applied to plastic parts while they are still in the molds of the forming machines.	General Tire & Rubber						
Deck Lids	Aluminum Alloy 2036 outer panel		1st U.S. auto industry use cars with extra options, including California cars.		GM	'78 Chevy Monte Carlo			4 BP	AMM/MN 7/25/77 p. 1
	Aluminum Alloy 5182 Inner Panel	Stamped				'78 Buick Regal			4 BP	AMM/MN 6/20/77 p. 15

FIGURE 5-6. MAJOR BODY PARTS SUMMARY SHEET (Continued)

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Hood	Aluminum		1st industry use	Reynolds	Ford	Lincoln-Versailles	Save 13 lb. from steel.		4 BP	AMM/MN 4/11/7 p. 24
	Aluminum			Reynolds	GM	'78 Caddy		Higher cost		
	Aluminum			Alcoa	GM	'77 Olds 88			4 BP	WAR 1/3/77 p. 4
	Aluminum Alloy 6009 or 6010 or 5182-SSF	Assembly System employs combination of tasks.	All-aluminum hoods optional on Buick Regals, steel hoods standard. New alloys lighter and more formable than usual aluminum alloys 2036 and 5182.	Reynolds (sole supplier alloy 5182-SSF) Alcoa (6009 or 6010) Resistance Welder Corp. (assembly system)	GM	'78 Buick Regals loaded with options and emission control devices.			4 BP	AMM/MN 4/25/77 p. 14
	Aluminum Alloy 6009				Ford	'78 Heavy Duty Truck Cabs.				
Body Panels	Aluminum Alloy 6% copper 0.5% zirconium	Unique process: air pressure forms alloy shapes on single die.	Process used mostly on complex shapes that would otherwise require fabricated assemblies from a number of different parts.	Tube Instruments	Aston Martin	Loganda		Lower tooling cost but high material cost	4 BP	AE 8/77 p. 18

FIGURE 5-6. MAJOR BODY PARTS SUMMARY SHEET (Continued)

MAJOR BODY PARTS SUMMARY SHEET CTP - MCI 11/22/77 BP p.5

COMPONENT	MATERIALS	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCES
Door	Sheet Molding Compound (SMC): Plastic/ fiberglass reinforced compound inner and outer panels with steel side impact beams	Shuttle technique developed which uses press only for compression of plastic mold with curing done outside.	Study by Owens-Corning included analysis of design, material thickness, construction and assembly techniques. Concluded 1.2 million plastic doors could be technically and economically produced annually. 13% increase in manpower results in 6X output.	Owens-Corning			29 lbs. (43%) steel= 68 lbs. SMC = 37 lbs.	Lower capital outlay ($22 million = 67% less) Lower production cost but higher material cost. $17 SMC $18.50 steel for 1.2 million. $25 per door for 250,000 today. Tooling 80¢ SMC $3 steel.	4 BP	WAW 10/77 AI 3/15/77 p. 36 AN 5/30/77 p. 8
Door Beams	HSLA Impact beams	Stamped one-piece units	Replaces roll-formed HSLA steel beams in both front and rear.	GM (Fisher Body)	GM	'78 Intermediate Chevy Malibu, Pontiac LeMans, Olds Cutlass, Buick Century	Lighter	Less costly	4 BP	AMM/MN 8/22/7 p. 12
	Steel		Steel side door impact beams.		Ford	'78 Fairmont/ Zephyr				

FIGURE 5-6. MAJOR BODY PARTS SUMMARY SHEET (Concluded)

5.8 MISCELLANEOUS COMPONENTS

5.8.1 Subject Area

This section includes information on components that are not specifically designated for another section, e.g., grilles, radiators, window brackets, bearings.

5.8.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to new technology and applications: COMPONENT, AUTO MANUFACTURER, TOOLING, MATERIALS, COST, FUEL ECONOMY, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for information which is most relevant to his current needs. For example, a search for information on bearings indicates that bearings must be redesigned to accommodate front-wheel drive and innovations are sought in materials usage and tooling as well as design characteristics.

Worksheets pertaining to miscellaneous components are found in Appendix B, Figure B-8.

5.8.3 Summaries

The summary sheet (Figure 5-7) included in this section consolidates the information found in the worksheets and presents an overview of various components. It was derived from the worksheets by quick referencing under component and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under weight reduction, auto manufacturer or other column topics.

MISCELLANEOUS COMPONENTS SUMMARY SHEET CTP - MCI 1/23/78 MI page 1

Component	Material	Tooling	Notes	Supplier	Auto Mfg. Models	Wt. Reduc.	Cost	Media Ref. Book	Reference
Grilles	Chrome-plated ABS (rigid) plastic and soft thermo-plastic urethane	Sputtering or vacuum metalizing	Great strides being made in chrome coated plastics. 1977 Chevy Caprice rigid plastic lower grille was first production application of chrome sputtering technique.	Sputtering system: Temescal Div. Airco, Inc.	GM	Reduces weight	Process more efficient and lower cost savings in energy and chrome.	4 MI	AMM/MN 8/29/77 p. 2
			1979 Chevy Chevette and Caprice will have rigid ABS plastic chrome coated grilles. Also planned for future Camaro cars.	Varian Assoc.	GM			4 MI	AMM/MN 10/24/77 p. 22
			GM testing chrome-sputtered soft plastic parts and upper grille application which would be a good alternative to electroplating. Chrome electroplated soft plastic parts do not work in the field partly because of pronounced differences between the hardness of the two materials.						
Window Brackets	Plastic		Replaced galvanized steel window brackets with plastic in 1977 LTD II and Cougar XR7.		Ford	1¼ lbs. per bracket		4 MI	AMM/MN 1/31/77 p. 7
Sealed Bearings		Set Right Method	Sealed bearings used on Ford Fiesta with front wheel drive. Production requires close tolerance control. Ford prepacks bearings with grease in sealed system.	Timken	Ford			4 MI	AN 7/11/77 p. 18
			General trend toward design of sealed bearings: (1) Bearings for Front Wheel Drive requires new tooling anyway; (2) Abandonment of regular service interval requires better factory sealed lubrication and better seal on bearings. (3) Use different materials--plastic, nylon, devlin, silicon nitride rolling element, powdered metal (some lighter weight). (4) Improved production quality.					4 MI	AI 7/1/77 p. 22

FIGURE 5-7. MISCELLANEOUS COMPONENTS SUMMARY SHEET

5.9 POWER ACCESSORIES

5.9.1 Subject Area

This section includes information on power accessories, e.g., rotary air-conditioning compressor, alternator, water pump, distributor, power steering, power brakes, generator, air pump and oil pump.

5.9.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to power accessory technology and applications: COMPONENT, MATERIAL, TOOLING, SUPPLIER, AUTO MANUFACTURER, MODEL, WEIGHT REDUCTION, COST, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs.

Worksheets pertaining to power accessories are found in Appendix B, Figure B-9.

5.9.3 Summaries

The summary sheet (Figure 5-8) included in this section consolidates the information found in the worksheets. It presents an overview of weight reduction techniques used for various power accessories. It was derived from the worksheets by quick referencing under component. Additional summary sheets can be prepared from the worksheets by quick referencing under other column topics.

POWER ACCESSORIES SUMMARY SHEET CTP - MCI 1/18/77 PA page 1

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	WT. REDUCTION	COST	MEDIA BK.	REF. NO.	REFERENCE
Rotary A/C Compressor			New compact rotary design said to provide greater mounting flexibility, minimum noise and vibration, use fewer parts. 4 different pulley and clutch designs available.	York Automotive Div. Borg-Warner		Weighs less than 15 lb. (plus 6½ lb. for oil and clutch).	$30 million over next 5 yrs. on plant.	4 4	PA PA	AI 7/15/77 p. 38 AE 2/77 p. 14
Alternator	Steel	Stamped		U.S.Steel		10% less than cast aluminum housing.		4	PA	AE 10/77 p5. ADV.
Water Pump	Al Alloy 309	Die Csst	Plans to replace current cast iron water pump on at least some V-8 engines on 1979 MY cars loaded with options, including reduced standard size models and Ford LTD, Mercury Marguis.	Kingsbury Machine Company	Ford	Al pump = 5½ lbs. Cast iron = 13½ lbs.		4	PA	AMM/MN 4/25/77 p. 13

FIGURE 5-8. POWER ACCESSORIES SUMMARY SHEET

5.10 ROOFS

5.10.1 Subject Area

This section includes information on auto roofs. Due to media reporting methods, emphasis is placed on special roofs, e.g., removable glass hatch roof, sliding metal sun roofs, glass moonroofs, flip tops, tinted glass sunroofs.

5.10.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to roof technology and applications: ROOF MANUFACTURER, AUTO MANUFACTURER, MODEL, MATERIALS, COST, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on auto manufacturer activities indicates GM, Ford and Chrysler each have facilities to install special roofs. The majority of special roofs, however, are still produced and installed by independent customizers.

Worksheets pertaining to roofs are found in Appendix B, Figure B-10.

5.10.3 Summaries

The summary sheet (Figure 5-9) included in this section consolidates the information found in the worksheets. It presents an overview of manufacturing activities for special roofs. It was derived from the worksheets by quick referencing by roof type under roof notes and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under other column topics.

ROOFS SUMMARY SHEET CTP - MCI 1/23/78 RO page 1

Types	Material	Notes	Supplier	Auto Mfg. Models	Cost	Media Ref. Book	Ref.
Special roofs: removable glass hatch roof, sliding metal sunroofs, glass moon-roofs, flip tops	Steel "spine" running back from middle of header to rear of roof. Later covered with an aluminum stamping.	Special roofs: have less steel and more glass and add 50 lbs. to car weight.	American Sunroof Co.	GM Ford	$600-1200 each. $150 million per year for 1/4 million cars.	4 RO	AMM/MN 8/22/77 p. 5
		Most roofs produced and installed by customizers, some installed by auto manufacturers, some produced as kits and installed by franchisers around country.	Cars and Concepts, Inc.	Chrysler		4 RO	AI 3/15/77 p. 18
		American Sunroof Co., Cars and Concepts Inc., and Specialty Car Division use similar process which involves attaching hardware through holes in glass. They use laminated glass (often supplied by Libby-Owens-Ford).	American Hatch Corp. made by Excel Industries	Numerous models 1977 1978			
		American Hatch Corp. uses different process in which glass is bonded to aluminum "surround" with a patented liquid adhesive and hardware is attached to metal surround. AHC claims this makes stronger hatch panel and eliminates leakage.	Specialty Car Div. (Hurst)				

FIGURE 5-9. ROOFS SUMMARY SHEET

5.11 SEATS

5.11.1 Subject Area

This section includes information on auto seats, e.g., all-plastic seats, and thin-backed seats.

5.11.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for special information which is most relevant to seat technology and applications: SUPPLIER, AUTO MANUFACTURER, TOOLING, MATERIALS, COST, FUEL ECONOMY, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on auto manufacturers who are involved with seat innovations indicates GM is planning to introduce all-plastic seats for the first time in Chevy Corvettes.

Worksheets pertaining to seats are found in Appendix B, Figure B-11.

5.11.3 Summaries

The summary sheet (Figure 5-10) included in this section consolidates the information found in the worksheets pertaining to improvements in automotive seat design. It was derived from the worksheets by quick referencing under material and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under auto manufacturer or other column topics.

SEATS

SUMMARY

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Material	Tooling	Notes	Supplier	Auto Mfg. Models	Media Ref. Book	Reference
Glass fiber reinforced polyester or polypropylene	Thermoplastic stamping or compression molded seat	First industry use all plastic seats planned for Fall 1978. Delayed until Spring 1978 because need to simplify steel wire retainer which is the only metal part.	Flex-o-Lators	GM Chevy Corvette	4 SE	AMM/MN 1/3/77 p. 14
					4 SE	AMM/MN 6/27/77 p. 10

FIGURE 5-10. SEATS SUMMARY SHEET

5.12 SUSPENSION AND STEERING

5.12.1 Subject Area

This section includes information on suspension and steering, e.g., springs, shock absorbers, MacPherson strut front suspension, and steering column switch assembly.

5.12.2 Indexing Method

Since worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to suspension and steering technology and applications: SUPPLIER, AUTO MANUFACTURER, MODEL, TOOLING, MATERIALS, COST, FUEL ECONOMY, WEIGHT REDUCTION, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on manufacturers who are involved with suspension innovations indicates several manufacturers are developing ways to make shock absorbers or air springs adjust to a wide load-range.

Worksheets pertaining to suspension and steering are found in Appendix B, Figure B-12.

5.12.3 Summaries

The summary sheet (Figure 5-11) included in this section consolidates the information presented in the worksheets. It presents an overview, by components, of improvements in suspension and steering technology. It was derived from the worksheets by quick referencing under component and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under supplier or other column topics.

SUSPENSION AND STEERING SUMMARY SHEET CTP - MCI 1/23/78 SS page 1

Component	Material	Notes	Supplier	Auto Mfg. Models	Cost	Media Ref. Book	Reference
Shock Absorbers: Steel Coil	Rubber & Aluminum	Predicts lighter, inflatable air springs to replace steel coil especially on smaller cars. Electric air compressors and electronic leveling controls would adjust inflation pressure to handle wide load-range.	Good-year			4 SS	WAW 10/77 p. 115
Shock Absorbers: Compressor-Reservoir System	Plastic Mount	Electric eye sensor within shock absorber triggers an electric air compressor which fills or exhausts shocks to keep a vehicle at its pre-determined level.	Monroe Auto Equip. Co.		Installation cost less.	4 SS	AN 10/10/77 p. 49
Leaf Springs	Glass Reinforced Plastic	Development stage, would replace steel hotspring 7 - 9 lbs. = glass 30 lbs. = steel	Owens-Corning Fiberglass Corp.			4 SS	AN 8/15/77 p. 16
Front Suspension	Polymer-coated sintered iron piston	MacPherson-like front suspension has coil spring separate from strut. Compact installation.		Ford Fairmont Zephyr	High replacement cost	4 SS	WAR 9/5/77 p. 284
	Bronze teflon-impregnated rod guide					4 SS	AE 10/77 p. 41
	Hard chrome plated piston rod						
Steering Column Switch Assembly	"Delrin" ocetal homo-polymer resin	Multifunctional switch controls starter, turn signal, headlights, washer/wipers, seat belt, open door safety alarm.	Kostal			4 SS	Dupont Auto Plastic News

FIGURE 5-11. SUSPENSION AND STEERING SUMMARY SHEET

5.13 TIRES

5.13.1 Subject Area

This section includes all information on tires, e.g., elliptical, compact, light weight, non-flat, radial, all weather tires. It also includes the unitized pneumatic tire assembly.

5.13.2 Indexing Method

Since the worksheets contain abstracts of articles arranged in a random sequence, columns have been created for specific information which is most relevant to tire technology and applications: TIRE DESIGN, AUTO MANUFACTURER, TIRE MANUFACTURER, MATERIALS, COST, WEIGHT REDUCTION, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for articles which are most relevant to his current needs. For example, a search for information on auto manufacturers who are involved with tire innovations indicates a lack of data on Chrysler and AMC. Ford, General Motors and Leyland, however, each have active programs in this area.

Worksheets pertaining to tires are found in Appendix B, Figure B-13.

5.13.3 Summaries

The summary sheet (Figure 5-12) included in this section consolidates the information in the worksheets and presents an overview of the various approaches to improvements in tire technology. It was derived from thw worksheets by quick referencing under tire design and incorporates the easy index system. Additional summary sheets can be prepared by quick referencing under tire manufacturer, or other column topics.

In addition, this section contains TABLE 5-9. SIGNIFICANT APPLICATIONS OF TIRES IN THE AUTOMOTIVE INDUSTRY, which lists by auto manufacturer, the types of tires currently used and the future changes in tire usage which have been announced.

TABLE 5-9. SIGNIFICANT APPLICATIONS OF TIRES IN THE AUTOMOTIVE INDUSTRY

1977	GM and Ford install 80-90% radials, Chrysler 40-60% radials on new models. Rate expected to reach 100% on new cars within next few years.
	Tire sizes F, G, and H were reduced 2-2½ lbs. without affecting performance for GM downsized standard cars.
	Goodyear announced new steel belted, squatter, higher pressure elliptical tire which requires special wheel but improves fuel economy and reduces rolling resistance. Could debut on 1979 models if approved.
	Media reports several tire manufacturers testing non-flat tires with special lubricant-cooler insert in hopes of eliminating spare tire.
1978	GM intermediates and Ford compacts have high pressure (60 psi) compact spare tire which saves 11-14 lbs.
	Goodyear introduced Tiempo, all-wealther steel belted radial tire for replacement market. Uniroyal also working on all weather tire.
	Leyland Mini 1275 world's first car to incorporate Dunlop Denovo non-flat safety tire at no extra cost.

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AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
		① Lighter weight: better manufacturing controls to remove bad material in carcass & tread. GM downsize '77 B cars. F,G.H tires 2½ lb. lighter. Limit in wt. reduction w/o affecting performance.					4 TI	AI 5/15/77 p. 27
		② power consumption: reduce <u>hysteresis</u> (material tendency to lose resiliency from repeated rolling)-- reduce rolling resistance. Tires lose energy as flatten out. Rolling resistance more or less independent of speed but changes in compounds and carcass construction have effect.	Carcass: nylon, steel, polyester, keylar, rayon				4 TI	MT 4/77 p. 18
		Companies studying changes in tread, cavity design, carcass materials, bead configuration particularly in radials to reduce rolling resistance.					4 TI	WAR 10/10/77 p. 323
		Power Savings: 20% reduction from first generation radial 10% next goal.	Aramid belts				4 TI	WAW 10/77 p. 95
		Tires consume 15-25% fuel on steady state operation on highway. Weight ranges 23 tires size 165SR-13	Steel, nylon, rayon, polyester		15.5-19.0 lb/tire			
	Goodyear	<u>All Weather Radial</u>: Tiempo. Traction better than polyester-steel radial but less than winter radial. Tire tread made from components especially formulated for studless winter tire-- softer than rubber so mileage lower, but exceed fuel economy, highspeed, handling, dry pavement traction of traditional tire.	All-weather radial. Steel-belted	$39 (BR 78-13) to $81.30 (IR-78)		More MPG	4 TI	AN 10/3/77 p. 19 WAW 10/77 p. 94

FIGURE 5-12. TIRES SUMMARY SHEET

AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
	Goodyear	Light Weight Spare Tire - full size, lightweight but lower performance and durability			Lower		4 TI	AI 5/15/77 p. 27
	Goodrich	Non-Flat Spare Tire Not in commercial production yet -- undergoing extensive testing to certify performance of internal structure, conventional tire with beefed up sidewalls.	Radial				4 TI	WAR 3/7/77 p. 76
Leyland	Dunlop Denovo	Leyland Mini 1275 for '78 World's 1st car to incorporate DD run flat safety tire at no extra cost.		No extra cost to customer			4 TI	WAR 8/15/77 p. 216
	Goodyear Firestone	Lubricant-cooler inside insert -- when tire goes flat liquid gradually released.	Fiber-glass Stabil-izer		7½ lbs. less		4 TI	AI 5/15/77 p. 27
	Rocker	Developed tire sealant and allied system that would reinflate tire -- eliminate spare and jack. Applied to inside of tire - stable, ductile, long life.		"Cost Advant".	4" shorter & several hundred lbs. lighter	Higher MPG	4 TI	MT 4/77 p. 18
	Yokohama Rubber Co. (Japan)	Production facilities available -- could sell in 6 mo. (to OEM) if demanded. Marketed under license.					4 TI	AN 7/11/77 p. 16
	Uniroyal	1st U.S. tire Co. to install Rocker system.					4 TI	
GM Ford	Goodyear Dupont Goodrich Uniroyal Firestone	Improve Radial Tire Performance: Use different materials; design of components (carcass, tread, bead). Fuel economy top priority but can't sacrifice safety, durability, traction. 2 ways save power: 10% reduction in power tire consumes--improve fuel economy 2%	Radial	Save $200 mil. in fuel	2½ lb. less in 1977. F, G, H	10% power reduction 2% increase in MPG.	4 TI	AI 5/15/77 p. 27 MT 4/77 p. 18

FIGURE 5-12. TIRES SUMMARY SHEET (Continued)

AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
	Zedron, Inc. (Baltimore)	Unitized pneumatic tire assembly eliminates metal wheel, tire-wheel mounting, metal wire bead, multiple layers fabric or wide cord piles of conventional pneumatics. Unitized Elastomeric structure with chemically bonded integral metal hub, sidewall inflation valve, and simulated spoke design. No information on current application.			Significant reduction (lbs. not given)		4 TI	AI 9/1/77 p. 54
Ford	Goodyear	Elliptical tire. Still in testing stage -- not have DOT approval yet (could take up to 9 mo.). Sidewall shorter and more curvilinear. Could debut on '79 MY cars (models not indicated). Special wheel -- may have problems with OEM and DOT if single-source supply Reduces rolling resistance 34% increases inflation pressure 50%, handling and smoothness same. When approved, could be in production within 90 days.	Radials Polyester cord with steel belts.	$25-$35 to consumers. Tires same wheel increase. Increase mileage of tire.	None	4-10% increase in MPG. Elliptical = 18.86 Steel Belt R= 17.52 Bias Ply = 16.22	4 TI	WAW 8/77 p. 9 WAR 8/1/77 p. 245 DFP 7/29/77 p. 9D AN 8/1/77 p. 6 WSJ 7/27/77 p. 6 WSJ 8/2/77 p. 11
GM Ford	Uniroyal Firestone General	Compact Spare Tire: for redesigned '78 MY intermediate cars (GM) and compacts (Ford). High pressure - not flatten out - only 1.25 in. less rolling radius when installed. Requires 1" larger wheel but total circumference 4" less. Trunk space: Saves 1.3 cu. ft. Life expectancy compact tire: 1,000-3,000 mi. (could last life of car if driven 50 miles every 18 mo.) Temporary use only - could drive 100 miles. Life expectancy new regular tires reduced 20% - only 4 not 5 regular tires.	4-ply bias	Price Spare less but buy more regular tires.	11-14 lbs. reduction. Compact-spare 30% less than regular spare 15-20 lbs. less than folding tire with infl. gas.	More MPG (assuming smaller car)	4 TI	AI 5/15/77 p. 14 AI 5/15/77 p. 27 AN 7/18/77 p. 39 WAR 8/29/77 p. 276

FIGURE 5-12. TIRES SUMMARY SHEET (Concluded)

5.14 WHEELS

5.14.1 Subject Area

This section includes information on vehicle wheels. The principal method of differentiating types of wheels includes a description of both the materials and processes used in wheel production, for example, fabricated aluminum wheels and forged aluminum wheels.

5.14.2 Indexing Method

Since the worksheets contain abstracts of articles arranged in a random sequence, columns for specific information most relevant to wheel technology and applications have been created: MATERIALS, TOOLING PROCESS, WHEEL MANUFACTURER, AUTO MANUFACTURER, COST, WEIGHT REDUCTION, FUEL ECONOMY, MEDIA REFERENCE BOOK NUMBER, and REFERENCE (original source). These columns allow the reader to quickly scan for information most relevant to his current needs.

Worksheets pertaining to wheels are found in Appendex B, Figure B-14.

5.14.3 Summaries

The summary sheet (Figure 5-13) included in this section presents an overview of various approaches to improvements in wheel technology. It was derived from the worksheets by quick referencing under materials and tooling process and incorporates the quick reference system. Additional summary sheets can be prepared by quick referencing under wheel manufacturer, auto manufacturer or other column topics.

In addition, this section contains TABLE 5-10. SIGNIFICANT DEVELOPMENTS IN WHEEL USAGE, which lists the historical events and announced plans for applications of improved wheel technology. These events are listed by year and manufacturer or supplier.

TABLE 5-10. SIGNIFICANT DEVELOPMENTS IN WHEEL USAGE

1960's	Pontiac offered first Aluminum wheel as an option (cast aluminum).
1973	Pinto - offered first forged aluminum styled wheel.
1974-76	Ford expanded use of forged aluminum styled wheels (Maverick, Mustang, Granada).
1977	Ford - first styled forged aluminum wheel became standard equipment (Versailles). Aluminum wheels offered on all other luxury cars.
	Chrysler offered styled forged aluminum wheels on Diplomat and LeBaron models.
	General Motors offering styled forged aluminum wheels.
	Alcoa fabricated Al-Mg 5454 wheels available for testing (spring).
	Stamped aluminum wheels feasible.
	Forged aluminum wheels on 29 1977 models. Soon to be on light-duty trucks and vans.
1978	Kelsey-Hayes w/Reynolds announced possibility of fabricated aluminum wheels on some MY 78 models.
	Production begins 7/1/78 for MY 79 cars.
1979	Fabricated aluminum wheels - produced by Kelsey-Hayes on some 1979 models, e.g., Chrysler R-Body.

WHEELS

SUMMARY SHEET

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WH page 1

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Aluminum	Casting but X-ray each	Easier than forged to make complex designs.			Lower than forged.				
Stainless Steel Pressings riveted to central flange of Alum. rim	Fabricated	Motorcycle wheel - ease in balancing wheel. Light weight but strong. Currently in use.		Honda	Lower Assembly Costs	Light Weight		4 WH	AE 47// p. 18

FIGURE 5-13. WHEELS SUMMARY SHEET

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Aluminum Mg. 5454	Fabricated similar to steel wheels.	Prototype quantity available for testing 2nd quarter 1977. Characteristics compete with conventional wheels: welding characteristics, fatigue strength, corrosion resistance, forming ability.	Alcoa			Alum. 50% lighter than steel 40-60 lbs. per car.		4 WH	WAR 4/25/77 p. 131 WAW 5/77 p. 30 AI 4/1/77 p. 119
Aluminum	Fabricated	400,000-800,000 to be produced starting 7/1/78 for '79 model passenger cars. Chances for '78 models excellent	Kelsey-Hayes W/Reynolds		$30 more for Alum. but savings on smaller simpler wheel.	1½ lb. direct 3/4 lb. indirect		4 WH	AI 4/1/77 p. 120 AI 5/15/77 p. 32 AE 5/77 p. 15 WAR 6/6/77 Special report
Aluminum	Fabricated	1979 downsized standard models - body size R. Number of cars or proportion of cars not known. Conventional stamping presses, dies and roll forming machines can be used.	Kelsey-Hayes	Chrysler	Lower production costs than forged or cast.	10 lb./wheel		4 WH	WAW 10/77 p. 88
Aluminum	Fabricated	Technology available but no demand yet. Stamped process simpler. Eliminate most of machine operations.	Alcoa		Lower production costs than forged or cast.			4 WH	WAR 6/6/77 Special report
Aluminum	Forged	Offered on 29 of industry's '77 MY cars → soon available on some light duty trucks and vans. Styled aluminum wheels at extra cost = 9.2% of cars MY 1977 (4.6% of 1976 MY with fewer cars). (Model styles attached.		GM Ford Chrysler					

FIGURE 5-13. WHEELS SUMMARY SHEET (Concluded)

6. VEHICLE WEIGHT CHANGE SCHEDULES

6.1 INTRODUCTION

This section culminates the effort under this contract to project the weights of passenger vehicles through 1985 by market class using weights reported in the media. Included in this section are the Vehicle Weight Change Schedules as reported in the media for each domestic manufacturer plus all the supporting documentation regarding weight savings expected through exponent modification. The tables presented here allow a user to obtain more detailed information about component weight savings (achieved and expected) than can be displayed on a single chart. They also provide the means for tracing information back to the original media reference sources, which includes articles published through April 30, 1978.

The three major subsections are described below:

6.2 VEHICLE WEIGHT CHANGE SCHEDULES AS REPORTED IN THE MEDIA

Figures 6-1 through 6-4 indicate that little information has been reported regarding vehicle weight after the 1979 model year. Weights which have been reported usually apply to specific models which were redesigned for a specific model year. In order to fill in the numerous "holes," additional analysis is required, which entails a study of other factors affecting vehicle weight (in addition to component alterations), and the manufacturer's particular strategy to be employed.

6.3 ANNOUNCED COMPONENT CHANGES

Announced Component Changes, contains TABLES 6-1 through 6-4, one for each manufacturer, entitled "Announced Component Changes Corresponding with the Savings". These tables are arranged by market class and list by year the component altered, the model(s), and the weight savings (or gain) realized.

These tables were constructed using information gathered in subsection 6-4 and Appendix C. Emphasis was placed on enumerating weight changes of components as reported in the media; media references cited can be found in these other sections. Again, however, the information sought was not always explicitly reported in the media. Most of the component changes reported involved models which were redesigned in the 1977 and 1978 model years or expect to be redesigned in the 1979 model year; decisions regarding component changes to vehicles in model year 1980 and beyond have not yet been completely formulated. In some cases, the media reports expected component changes but does not report corresponding weight changes; where possible, weights have been estimated based on the weight change announced for other models of that manufacturer or another manufacturer. Even though, there were still numerous "holes" in the data.

The major value in collecting data and analyzing component changes lies in the fact that technological changes applied by one manufacturer on one model can be expanded in use for other models and eventually to all manufacturers. Also, although certain components may not reduce weights dramatically if applied individually, major reductions can be achieved in the aggregate.

6.4 COMPONENT WEIGHT CHANGES AS REPORTED IN THE MEDIA

Component weight changes as reported in the media, Figures 6-5 through 6-18, is organized by components. Emphasis is placed upon identifying weight savings associated with specific material and design changes as reported in the media. Columns have been created to highlight the component, auto maker, model year, model, material (whether new or conventional) the weights of the old and new components and the difference between them, the media reference volume in which the autos can be found and the original reference source.

This section was generated using information extracted in Appendices A and B of this volume and updated to express the new information reported between November, 1977 and May, 1978.

Appendix C, Component Inventory by Model, contains two types of matrices for each manufacturer's market class. One relates specific components to particular models and highlights the model year in which the component change would occur. The other cross-references the original media reference with numerous components. By searching the component list, a user can find all the articles which refer to the use of that component in at least one model in that market class.

GENERAL MOTORS VEHICLE WEIGHT CHANGE SCHEDULE AS REPORTED IN THE MEDIA 4/30/78 CTP

	MODEL YEAR										
Market Class	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
Luxury-Standard	4453-5892	3917-5101	3882-5052	①⑦ 3767-4894 ⑫ 3767-4052	②③ 3400-4694			⑩ 3245-4047			
Standard	4238-5137	3606-4343	3510-4408		③ 3310-4208			⑩ 2883-3543		⑧ 3250	
Intermediate	3712-4649	3616-4493	3313-4289						⑦ 2770	⑧ 2770	
Compact	3331-3873	2669-3686	3129-3692		④⑤⑪ 2250-3000					⑧ 2530	
Subcompact	2473-3541	2533-3534	2665-3572		⑥ 2665-3134	⑬ 3010	⑬ 2810		⑨⑬ 2390	⑧ 2390	
Mini	1931-1981	2019-2069	1991-2101								

All Weights Reported are Curb Weights.

① AN 12/19/77 p. 3
② AN 2/27/78 p. 27
③ WAR 2/6/78 p. 43
④ PS 3/78 p. 46; AN 11/7/77 p. 2
⑤ AN 10/24/77 p. 58; MT 5/77 p. 49
⑥ AN 8/8/77 p. 3; Corvette downsized
⑦ Includes Limosines
⑧ AI 6/1/77 p. 29, Weights reported are inertia weights. They have been adjusted to curb weights for this chart.
⑨ PS 3/78 p. 46
⑩ WAR 2/6/78 p. 43; AN 2/6/78 p. 1 Report different weight losses. Used compromise weight loss of 700-800 lbs; i.e., 700 lbs. from low end and 800 lbs. from high end of weight range.
⑪ WAW 4/78 p. 9
⑫ New E-Body
⑬ WEU 5/13/77 p. 4, average weight.

FIGURE 6-1. GENERAL MOTORS VEHICLE WEIGHT CHANGE SCHEDULE

FORD VEHICLE WEIGHT CHANGE SCHEDULE AS REPORTED IN THE MEDIA 4/30/78 CTP

MODEL YEAR

Market Class	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
Luxury-Standard	5006-5227	4971-5052	4757-4936								
Standard	4451-5019	4414-4931	4266-4859	3481-4027 ①							
Intermediate	4137-4764	3916-4698	3913-4331								
Compact	2980-3600	2999-3562	2706-3358								
Subcompact	2562-3070	2443-3000	2425-2982	2498-2870 ①②							
Mini			1775								

All Weights Reported are Curb Weights

① AN 3/6/78 p. 1
② WEU 3/17/78 p. 1

FIGURE 6-2. FORD VEHICLE WEIGHT CHANGE SCHEDULE

CHRYSLER VEHICLE WEIGHT CHANGE SCHEDULE AS REPORTED IN THE MEDIA 4/30/78 CTP

MODEL YEAR

Market Class	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
Luxury-Standard	4905-5090	4780-5061	4712-4912	3500-4000 ④						3500 ⑥	
Standard	4215-5165	4213-4980	4503-4703	3500-4000 ④							
Intermediate	3695-4580	3611-4515	3525-4813		3000-3500						
Compact	3290-3920	3256-3830	3229-3753			2629-3053 ①					
Subcompact			2121-2137 ②③								

All Weights Reported are Curb Weights

① AN 2/20/78 p. 117
② AN 12/22/77 p. 6; WAR 12/12/77 p. 397
③ AI 12/1/77 p. 13
④ WAR 12/26/77 p. 1; AMM 6/13/77 p. 1; AMM 2/28/77 p. 6
⑤ WAW 1/78 p. 9
⑥ AN 2/29/78 p. 117, average weight

FIGURE 6-3. CHRYSLER VEHICLE WEIGHT CHANGE SCHEDULE

AMC VEHICLE WEIGHT CHANGE SCHEDULE AS REPORTED IN THE MEDIA 4/30/78 CTP

	MODEL YEAR										
Market Class	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
Intermediate	3632-4165	3751-4224	3709-4349	Dis- ① continued							
Compact	3107-3343	3049-3317	3027-3452								
Subcompact	2761-3010	2656-2881	2552-3074								
Mini											

All Weights Reported are Curb Weights

① WSJ 4/14/78 p. 8

FIGURE 6-4. AMERICAN MOTORS VEHICLE WEIGHT CHANGE SCHEDULE

TABLE 6-1. FOOTNOTES TO ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS

① Optional
② Standard equipment
③ Running change
④ Selected models such as:
California or cars loaded with options or certain engines
⑤ Front
⑥ Rear
⑦ Special models (anniversary models)
⑧ Except XR-7
⑨ Standard on cars w/radials
⑩ Standard on cars w/302CID V-8
⑪ Station Wagon
⑫ Standard on cars w/5 liter engines (351 CID V-8)

Ⓐ replaces steel
Ⓑ replaces iron
Ⓒ replaces Al

Front end ≡ Fascia (or Facia) ≡ bumper, fender extension, hood extension, grille frame and headlamp bezels.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS

Luxury Standard	Body Type	Component	Model	Wt. Savings (lbs.)
1966	E	Front Wheel Drive	Toronado	50*
1967	E	Front Wheel Drive	Eldorado	50*
1977	C	Al Hood	Cadillac ④	50*
	E	New FWD Chain	Toranado	2.0
	C	Frame	Cadillac	109**
	C	Body	Cadillac	389-396**
	C	Front sheet metal	Cadillac	65**
	C	Bumpers	Cadillac	69**
	C	Engine-smaller Size offered	Cadillac	93**
1978	C	One Piece FRP Steering Column	Cadillac Electra Olds 98	0.6 C
	E	One Piece FRP Steering Column	Eldorado Toronado Riviera	0.6 C
	C E	Automatic Level Control	Olds 98 ① Toronado ①	
	C	Plastic Fender Liners	Cadillac ③	10/car
	C	Nodular Iron	Cadillac ⑥	2
	B	Hypoid Gears	Riviera ⑥	2
	E	MISAR Engine Control	Toronado	
	C	Diesel Engine (350 V-8 gas)	Olds 98	+111-130
	E	Chrome Plated HSS Face Bars	Eldorado ④	
	E	HSS Steering Sys. Reinforcements	Eldorado	
1979	E	Front Wheel Drive	Riviera	50*
	E	Al Reinforcement Bars	Eldorado	10*
	C/E	Tamperproof Carburetor	Cadillac ② Electra ② Olds 98 ② Eldorado ② Toronado ② Riviera ②	not significant
	C/E	Diesel Engine (350 V-8 gas)	Cadillac ① Toronado	+111-130
	E	HSLA Steel Wheels	Eldorado Ⓑ Toronado Ⓑ Riviera Ⓑ	12.5 lbs./car * (10% per wheel)

* Weight estimates based on similar changes on other models or by other manufacturers.

**weights taken from prior CTP contract DOT/TSC-1305.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Continued)

Luxury Standard	Body Type	Component	Model	Wt. Savings (lbs.)
1980	C/E	Phase II Catalyst	All ④	
	C	New Sheet Metal	Cadillac Electra Olds 98	
	C	HSLA Steel Wheels	Cadillac Ⓑ	12.5 lbs./car *
1981	C/E	Phase II Catalyst	Cadillac ② Olds Buick	
1983	C	Front Wheel Drive	Cadillac ② Olds 98 Electra	50*
Standard				
1977	B	Al Outer Hoods	Olds 88	2B*
	B	Reduced Tire Tread	B-O-P Chevrolet	2 - 2½
	B	Chrome-Sputtered Plastic Grilles	Chevrolet Caprice	
	B	HSLA Steel Frame	B-O-P Chevrolet	60-90
	B	Turbohydramatic transmission	Pontiac	58 lbs. **
	B	Bumper: HSLA steel w/Al.	Caprice	120**
	B	"Pulse Air"	Chevrolet	15**
	B	Body reduced	Caprice LeSabre	200** 181**
	B	Lighter suspension and brakes	Chevrolet	100**
		Front sheet metal	LeSabre	27**
	B	Al intake manifold	Chevrolet ① ④	25.5**
	B	Single level intake manifold	Pontiac	19**
	B	Engine: less mass	8/260 8/350 8/301	59** 52** 20**
1977½	B	Nodular Cast Iron Hypoid Gears	Pontiac	2/set
1978	B	Diesel Engine (replaces 8/350 gas)	Olds 88	+111-130
	B	FRP Steering Column	B-O-P Chevrolet	0.6
	B	Turbocharge V-6 Assembly	Buick ①	+17.5*
	B	Fiberglass Belted Radials	B-O-P Chevrolet	1
	B	Automatic Level Control(rear shock)	Olds 88 ①	
	B	Nodular Cast Iron Hypoid Gears	Chevy ⑥ Olds Buick	2
	B	Al Intake Manifold		31

* Weight estimates based on similar changes on other models or by other manufacturers.

** Weights taken from prior CTP contract DOT/TSC-1305.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Continued)

Standard	Body Type	Component	Model	Wt. Savings (Lbs.)
1979	B	Tamperproof Carburetor	B-O-P Chevrolet	Not Significant
1980	B	New Sheet Metal	B-O-P Chevrolet	
	B	Phase II Catalyst	B-O-P Chevrolet	
1981	B	Phase II Catalyst	B-O-P Chevrolet	
1983	B	Front Wheel Drive	B-O-P Chevrolet	50*

Intermediate	Body Type	Component	Model	Wt. Savings (Lbs.)
1978	Asp	SMC Front-End Reinforcement	Monte Carlo	
	A/Asp	Al Hoods	Cutlass ④ Ⓐ Grand Prix ④ Ⓐ Regal ④ Ⓐ	28 50
	A/Asp	Al Master Brake Cylinder	B-O-P Chevrolet	6.5
	A/Asp K	FRP Steering Column	B-O-P Chevrolet Seville	0.6
	Asp	Turbocharge V-6 (turbocharge components)	Regal ①	+17.5*
	A/Asp	Al Brakedrum	B-O-P Chevrolet	11.46
	A/Asp	Chrome Plated HSLA Steel with Al Reinforcements	Century ④ Cutlass Malibu Regal Grand Prix	36.5/car Al bar = 10 lbs.
	A/Asp	RIM Fascias	LeMans Monte Carlo	Bumper 100 lbs. less than '77
	A/Asp	Plastic Fender Liners	Chevy, Olds, Buick	10/car
	A/Asp	Al Intake Manifold	All except Grand Prix	25 - 31*
	Asp	Al Deck Lids	Monte Carlo ④ Regal	46
	A/Asp	Al Wheels	Pontiac ①	45*
	A/Asp	Compact Spare Tire	B-O-P Chevrolet	11-14 /car 13-22(w/wheel)
	A/Asp	Reduced Wheel Size	B-O-P Chevrolet	11-14 /car 27 (w/tire)
	A/Asp	Plastic Fender Skirts	Chevrolet	8.6
	A/Asp	Fixed Rear Window No Window Regulator	B-O-P Chevrolet	36.6/door
	A	Fiberglass Belted Radials	Malibu	1 lb. less* than steel
	A	Sun Roof	Cutlass ①	+ 50
	A	Automatic Level Control	Cutlass ①	

* Weight estimates based on similar changes on other models or by other manufacturers.

** Weights taken from prior CTP contract DOT/TSC-1305.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Continued)

Intermediate	Body Type	Component	Model	Wt. Savings (Lbs.)
1978				
	A/Asp	Radial 4-cyl. A/C Compressor	Pontiac	
	A/Asp	Al Radiator Support	Pontiac	10*
	A/Asp	Thinner Glass	B-O-P Chevrolet	15/car
	A/Asp	SMC Front-End Header Panels	Chevrolet	7-12
	A/Asp	Redesigned Disk Brake	B-O-P Chevrolet	2.2
	A	Stamped HSLA Steel Door Beams	B-O-P Chevrolet	
	A/Asp	HSLA Steel Frame	B-O-P Chevrolet	70
1978	K	Tripmaster	Seville	
	K	Electronic Spark Selection	Seville	
1978½	K	Diesel Engine (replaces 350 V-8 gas)	Seville	+111 - 130
1979	A/Asp	Tamperproof Carburetor	B-O-P Chevrolet	Not Significant
	A/Asp	Dual Jet Carburetor	B-O-P Chevrolet	Not Significant
	A/Asp	Diesel Engine (replaces 260 V-8 gas)	Olds Cutlass ①	+100*
1980	A/Asp K	Phase II Catalyst	B-O-P Chevrolet Seville	
	K	Front Wheel Drive	Seville	50*
1981	A/Asp K	Phase II Catalyst	B-O-P Chevrolet Seville	
Compact				
1978	X/F	Al Intake Manifold	Skylark Omega Ventura Nova Camaro Firebird	12*
	F	RIM Bumper Ⓒ	Camaro Firebird	85*
	X	Glass FRP Header Panels	Skylark	7*
1979	X/F	Tamperproof Carburetor	All	Not Significant
	X/F	Dual Jets Carburetor	All	Not Significant
1980	X	Front Wheel Drive	All	50*
	X/F	Phase II Catalyst	All ④	
	X	HSLA Steel Wheels	Skylark Ⓑ Omega Ventura Nova	39*

* Weight estimates based on similar changes on other models or by other manufacturers.

** Weights taken from prior CTP contract DOT/TSC-1305.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Continued)

Subcompact	Body Type	Component	Model	Wt. Savings (Lbs.)
	X	Al Cowl Vent Panels	Skylark Ⓑ Omega Ventura Nova	7*
1981	X/F	Phase II Catalyst	All ②	

Subcompact	Body Type	Component	Model	Wt. Savings (Lbs.)
1977	Y	Al Transmission Case	Corvette	70
1978	Y	All Plastic Front Seat	Corvette ⑦	24/car
	Y	Plastic Fuel Tank w/Steel Liner	Corvette	6*
	Y	Al Wheels	Corvette ①	40*
1978½	Y	Fiber Reinforced Plastic Removable Roof Panels	Corvette ①	
1979	Y	All Plastic Front Seat	Corvette ②	24/car
	Y	Tamperproof Carburetor	Corvette	Not Significant
1980	Y	Phase II Catalyst	Corvette ④	
	Y	Phase II Catalyst	Corvette ②	
	Y	Plastic Body Panels via Inmold Coating	Corvette	over 90
1980-1982	Y	Plastic Hood	Corvette	10
1978	Hsp	Al Intake Manifold	Starfire Monza Sunbird	12*
	Hsp	Al Wheels	Monza Sunbird	40*
	Hsp	RIM Fascias	Starfire Skyhawk Monza	70*
	Hsp	Phase II Catalyst	Starfire ④ Monza ④ Sunbird ④	
1979	Hsp	Tamperproof Carburetor	Starfire Monza Skyhawk Sunbird	Not Significant
1980	Hsp	Phase II Catalyst	Skyhawk	
1981	Hsp	Phase II Catalyst	Starfire Monza Skyhawk Sunbird	

Mini	Body Type	Component	Model	Wt. Savings (Lbs.)
1978½	T	Automatic Seat Belt	Chevette	Add 10 (2 pt. sys.) [Add 6-7 (3 pt. sys.)]

* Weight estimates based on similar changes on other models or by other manufacturers.

TABLE 6-2. GM ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Concluded)

Mini	Body Type	Component	Model	Wt. Savings (lbs.)
1979	- T	Al Intake Manifolds	Chevette	12* (over Cast Fe)
	T	Chrome Sputtered Plastic Grilles	Chevette	
	T	Tamperproof Carburetor	Chevette	Not Significant
	T	Dual Jet Carburetor	Chevette	Not Significant
1979-1980	T	All Plastic Front Seat	Chevette	24*/car
1980	T	Phase II Catalyst	Chevette	
1981	T	Phase II Catalyst	Chevette	

* Weight estimates based on similar changes on other models or by other manufacturers.

TABLE 6-3. FORD ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS

		Model/body	Wt. savings (lbs.)
Luxury-Standard			
1978	Mild steel facebar, Al reinforcement		
	Lt. wt. power steering pump		5
	Al wheels		50*
Standard			
1978	Lt. wt. power steering pump	LTD, Marquis	5
	Aerodynamic drag devices:		
	Front bumper air spoilers	LTD, Marquis ④	
	Rear floor pan air deflector	LTD	
	Bumper to fender shields	LTD	
	Underbody rear deflector	Marquis	
1979	Al intake manifold	LTD, Marquis	20*
	HSS face bar w/Al bumper reinforcement	LTD, Marquis ④	
	Chrome Plated Al bumpers	LTD, Marquis ① (6 or 5)	
	Thinner glass	LTD, Marquis	
	HSS suspension	LTD, Marquis	
	HSS reinforcements	LTD, Marquis ③	
	HS mounting brackets	LTD, Marquis	
	Cast Mg housing w/tilt-type steering columns	LTD, Marquis	
	Al engine rear cover plates	LTD, Marquis	1-2
	Al water pump	LTD, Marquis ④	
	HSS frames	LTD, Marquis	
	Redesigned rear axle	LTD, Marquis	9-28
	EEC II	LTD, Marquis ④	
Intermediates			
1977	Plastic window brackets	Cougar ③Ⓐ Torino/LTD	5
1977½	Aluminum hood	Versailles ③Ⓐ	33 lbs.
1978	Al wheels	Versailles ②	
	Aerodynamic drag devices:		
	Front bumper air spoilers	Cougar/LTD II	
	Deck lid spoilers	Cougar ⑧	
	Bumper to fender shields		
	Light wt. power steering pump	All models	5 lbs.
	EEC-I	Versailles	
	T-roof	T'bird ① ⑬	+50
1980	Plastic radiator supports		
	Front wheel spindle	T'bird Cougar	

* Weight estimates based on similar changes made by other auto manufactuers.

TABLE 6-3. FORD ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Continued)

		Model/body		Wt. savings (lbs.)
Compacts				
1978	Al wheels	Granada/ Monarch		
	Al reinforcements	Granada/ Monarch		
	Al intake manifold (8/302)	Granada/ Monarch	④	30
	Aerodynamic drag devices:			
	Front bumper air spoiler	Granada/ Monarch		
	Partially closed grille	Granada/ Monarch		
	Bumper to fender shields	Granada/ Monarch		
	Deck lid spoilers	Granada/ Monarch		
	Al bumpers	Fairmont/ Zephyr		56
		Granada/ Monarch		80
	HSLA steel bumper reinforcement	Fairmont/ Zephyr		
	Compact spare tire	Fairmont/ Zephyr		5-7 lbs.*
	Radial tires (steel)	Fairmont/ Zephyr		negligible
	HSLA steel door beams	Fairmont/ Zephyr		
	HSLA steel frame	Fairmont/ Zephyr		3.5
	Al steering gearhousing	Fairmont/ Zephyr		5
	Lt. wt. power steering pump	Fairmont/ Zephyr		5
	Plastic instrument panel	Fairmont/ Zephyr		6.5*
	Plastic headlight housing	Fairmont/ Zephyr		
	Plastic hood cowl	Fairmont/ Zephyr		
	Plastic grille	Fairmont/ Zephyr		
	Thinner glass	Fairmont/ Zephyr		
	Plastic windshield wiper	Fairmont/ Zephyr		
	Al master brake cylinder	Fairmont/ Zephyr	Ⓑ	
Subcompacts				
1974	Al intake manifold			
1977	Al bumpers	Pinto/ Bobcat		67
1977½	T-roof	Mustang	①	+50
1978	Plastic fuel tank	Mustang	Ⓐ ④	
	Al face bar bumper	Pinto/ Bobcat		
	Urethane face bar	Mustang		
	HSLA reinforcement	Mustang		
	3-way catalyst	Pinto/ Bobcat	④	

* Weight estimates based on similar changes made by other auto manufacturers

TABLE 6-3. FORD ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Concluded)

		Model/body	Wt. savings (lbs.)
Subcompacts			
1978	Al wheels	Pinto/ Bobcat	
	Lt. wt. power steering pump	All models	5
	Electronically controlled carburetor	Pinto/ Bobcat	④
1979	Elliptical tires	Mustang/ Capri	negligible
	RIM facia		
	Plastic front & rear ends	Mustang	200
1980	2.3 ℓ engine	Pinto/ Bobcat	
1981	Al transmission case	Bobcat	20*
	Al water pump	Bobcat	8
	Turbocharge 4-cyl. 1.6	Pinto	
Mini			
1978	Thinner glass	Fiesta	

* Weight estimates based on similar changes made by other auto manufacturers.

TABLE 6-4. CHRYSLER ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS

		Body/Model	Wt. savings (lbs.)
Luxury Standard			
79			
	Al wheels	R-body ②	50
	Chrome plated Al bumpers	R-body ①	55
	Plastic front end panels	R-body	10*
	Al intake manifold: 8/318	R-body	20-30
80	Al cylinder block 8/318	R-body ①	50
81	Thin wall cast Fe 6/225 engine		105
	Thin wall cast Fe 8/318 engine		70-120
Standard			
81	Thin wall cast Fe 6/225 engine		105
	Thin wall cast Fe 8/318 engine		70-120
Intermediates			
77	1-piece HSLA steel bumper	B-body ③	23
78	T-roof	Cordoba ①	+50 lbs.
	Sheet metal	③	3 lbs.
81	Thin wall block cast Fe 225 CID-6	B&M-bodies	105
Compact			
77	Series IV light weight brake	Valiant	5.11
78	HSLA steel face bar	Volare/Aspen Diplomat	34 21
	Al intake manifold	Diplomat ③	12
	Al master brake cylinder		½ (piston)
	Compact spare	Diplomat ②	3-4*
	Al wheels	Diplomat	45*
	Sheet metal	Diplomat	6.5-9.7
	Air conditioning	①	10.2
Subcompact			
78	FWD	Omni/Horizon ②	50.0 lb.*
	Soft front end	Omni/Horizon ②	
	Al bumpers	Omni/Horizon ②	67.0*
	Al master brake cylinder	Omni/Horizon ②	5.0*
	Al intake manifold	Omni/Horizon ②	12.0*
	Steel unit frame	Omni/Horizon ②	
	HSS suspension	Omni/Horizon ②	
	Al cylinder heads	Omni/Horizon ②	
	Al transmission housing	Omni/Horizon ②	
	HSS hood	Omni/Horizon ②	3.7

*Weight estimates based on similar changes made by other auto makers.

TABLE 6-4. CHRYSLER ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS (Concluded)

		Body/Model	Wt. Savings (lbs.)
Subcompact cont.			
78	HSS windshield wipers	Omni/Horizon ②	
	HSS brake pedals	Omni/Horizon ②	
	HSS gearshift mounting reinforcements	Omni/Horizon ②	
	HSS fuel tank supports	Omni/Horizon ②	
	Aspirator replacing air pump	Omni/Horizon ②	15*
	High pressure radial tire	Omni/Horizon ②	negligible
79	Al wheels	All subcompacts	40*

* Weight estimates based on similar changes made by other auto makers.

TABLE 6-5. AMC ANNOUNCED COMPONENT CHANGES WITH CORRESPONDING WEIGHT SAVINGS

	Component	Models	Wt. Savings
Compact			
1977	Bumpers - mild steel	All	(baseline)
	Aluminum transmission case	Gremlin[1] Hornet, Pacer	20 lbs.
	HSLA steel, sill area	Hornet, Gremlin	3.44
	Body lost 3"	Gremlin	85.0
	Emission controls added	Gremlin	+54.0
	4-cylinder engine	Gremlin	245 lb.
1978	Aluminum wheels	Pacer	50 lbs.*
	HSLA steel face bars	Pacer	30 lbs.
	2.ℓ engine	Hornet/Concord[2]	
	CYCOLAC Z-48 instrument panel	Concord	5 lbs. *
Subcompact			
1979	121 CID Audi 4-cylinder	Javelin	
	4-speed gear box	Javelin[1]	50 lbs. *

* Weight estimates based on similar changes made by other auto makers.

COMPONENT WEIGHT CHANGES

BRAKES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MEO. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
MASTER BRAKE CYLINDER/RESERVOIR											
Master Brake Cylinder / Reservoir		GM	1978		Cast FE Glass filled nylon	8.1 lb.	3.5 lb.	4.7 lb.	8.2 lb. still produced 3.5 lb. new design 2.5 lb. refinement in drum brake; some pieces eliminated.	4 BR	AN 2/27/78 p. 8
Master Brake Cylinder / Reservoir		GM	1978	Inter-mediates	Anodized Al (N) Reinforced plastic (N)	8.2 lb/ cylinder (1977) cast Fe	1.7 lb.	6.5 lb. (78%)	Delco Moraine Division of General Motors	4 BR	AI 10/1/77 Advertisement
Brake Cylinder/ Piston		C	1978		Phenolic	20 oz. (Steel)	12 oz. (phenolic)			4 TI	AI 12/1/77 p. 102
BRAKE DRUM											
Drum-brake		GM	1978					2.5 lb/car	new design, backing plate lighter.	4 BR	AI 11/15/77 Advertisement
Rear Brake Drum		GM	1978	B-O-P, Chevy Inter-mediates	Al			11.46 lbs.		2 G 4 MI 4 BR	WAW 9/77 p. 43 AI 10/1/77 p. 24 WAR 8/29/77 P. 275

FIGURE 6-5. COMPONENT WEIGHT CHANGES - BRAKES

COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
DISK BRAKE											
Disk Brake		GM	1978	Midsize		10.9 lb. per brake	8.7 lb. per brake	2.2 lbs.	Delco Moraine	4 BR	AI 11/15/77 Advertisement
		C	1978 (expected)	101-111 in wheel base. 2500-3600 lb. c.w.	Al (N)	12.6 lbs. (Fe)	7.5 lb.	5.11 lbs. (40.5%)	Series IV	4 BR	AE 5/77 p. 44
		C	1978 (expected)	93-100 in wheel base. 1900-2300 lb. c. w.		6.75-9.75 (lb.)	4.5 lb.	2.25-5.25 (33-54%)	Series IV	4 BR	AE 5/77 p. 44
POWER BRAKES											
Power Brake Support Bracket					Carbon steel (o) HSLA steen (n)	*1.67 lb.	*1.17 lb.	30% ½ lb./car	Republic Steel one-piece (old=2 piece) *calculated	4 PA	AI 2/1/78 p. 14
Power Brakes Booster		GM	1978					3.5 lbs. (over 1974)	Delco Moraine	4 PA	AI 11/15/77 Advertisement

FIGURE 6-5. COMPONENT WEIGHT CHANGES - BRAKES (Concluded)

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COMPONENT WEIGHT CHANGES

BUMPERS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
HIGH STRENGTH STEEL BUMPER WITH STEEL REINFORCEMENT BAR											
Bumper and Face Bar		C	1978	Aspen	High strength Steel			34 lbs.		4 MI	AN 11/7/77 p. 38
		C	1978	Diplomat	High Strength Steel			21 lbs.		4 BU	AMM/MN 6/27/77 p. 1
		A	1978	Pacer	High Strength Steel			30 lbs.		4 BU	WAR 9/26/77 p. 206
Bumper		C	1978½	Fury, Monaco Intermediates	One piece high strength steel	69 lb. (mild steel)	46 lb.	23 lbs.	Mid year running change	4 BU	AMM/MN 6/20/77 p. 14
Rear Bumper Outer Panel		GM	1978	Eldorado	High strength steel (VAN-QN based on GM 980X)				J & L Steel	4 BU	AMM/MN 1/30/77 p. 8
Bumper								2% GVW large cars, 10 lbs. small cars	U.S.Steel	4 BU	AI 8/1/77 p. 72 Advertisement

FIGURE 6-6. COMPONENT WEIGHT CHANGES - BUMPERS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. BOOK	REF. NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL				
HIGH STRENGTH STEEL BUMPER WITH ALUMINUM REINFORCEMENT BAR												
Bumper/ Bar		GM	1978	Most intermediates: Cutlass, Century, Regal, Chevelle	Chrome-plated steel bumper. Al. reinforcement bar.			36.5 lbs.	Not LeMans, Monte Carlo, Grand Am, Camaro	4	MI	AI 10/1/77 p. 24
									Reynolds	4	BU	AMM/MN 6/20/77 p. 15
Bumper/ Bar		GM	1978½	Olds Cutlass	Steel bumper Al. bar.		10 lbs. per reinforcement bar	65% less than steel reinforcement.	Same dies used.	4	BU	AMM/MN 2/6/78 p. 10
										4	BU	AMM/MN 2/6/78 p. 13
Bumper/ Bar		GM	1979	Eldorado (downsized)	High strength steel (dual phase 80) Al reinforcement bar.				U.S.Steel Also redesigned.	4	BU	AMM/MN 1/30/77 p. 8

FIGURE 6-6. COMPONENT WEIGHT CHANGES - BUMPERS (Continued)

COMPONENT WEIGHT CHANGES

BUMPERS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
ALUMINUM BUMPERS											
Bumpers					Aluminum			60-70% less than steel		4 BU	WAW 5/77 p. 66
Bumpers		C	1978	Omni/ Horizon	Aluminum					4 BU	WAR 12/1/77 p. 397
		F	1978	Fairmont/ Zephyr	Aluminum X7029			56 lbs.	Reynolds	4 BU	AE 11/77 p. B7
		F	1977	Pinto, Bobcat	Aluminum			67 lbs. less (55%)	Reynolds Car 75 lbs. less	4 BU	WAR 2/77 p. 72.
								80 lbs. less		4 BU	AN 1977 p. 22 Market Book
		F	1978	Granada Monarch	Aluminum						
								60-70% less 55 lb/car	Houdaille Industries	4 BU	AMM/MN 7/4/77 p. 1
		C	1979	R-Body	Aluminum					4 BU	WEU 4/14/78 p. 3
Chrome Plated Al Bumpers		F	1979	1/5 Panther line.	Aluminum				Several Suppliers	4 BU	AMM/MN 5/23/77 p. 24
				Ford Wagons,	Aluminum				Front Bumpers	4 BU	WAW 10/77 p. B7
				Mercury Wagons.	Aluminum				Rear Bumpers	4 BU	WAW 5/77 p. 66

FIGURE 6-6. COMPONENT WEIGHT CHANGES - BUMPERS (Continued)

BUMPERS

COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MEO. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
PLASTIC BUMPER											
Bumper		VW	1978	Dasher	RIM Polyurethane			15% less	Less than steel with hydraulic shock absorbers.	4 BU 4 BU	AE 10/77 p. 54 AMM/MN 10/3/77 p. 16
Bumper		GM	1978	Monte Carlo	Painted plastic outer skin			100 lbs. less than '77 MY		4 BU 4 BU	AN 8/29/77 p. 3 AMM/MN 4/24/78 p. 22

FIGURE 6-6. COMPONENT WEIGHT CHANGES - BUMPERS (Continued)

COMPONENT WEIGHT CHANGES

BUMPERS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
PLASTIC FRONT END PANELS											
Front End Header Struts		GM	1978	Chevy Inter-mediate	Plastic			8.6 lbs.		4 MI	AI 10/1/77 p. 24
Front End Panels		C	1979	R-Body	Plastic					4 BU	WAW 10/1/77 p. 24
Front End Header Panels		GM	1978	Monte Carlo,	SMC Plastic		10.7 lbs.	12 lbs.	Replace Steel grille sourrounds and hood extension; zinc end caps.	4 BP	AMM/MN 7/25/77 p. 14
		GM	1978	Malibu				7 lbs.			
		GM	1978	Malibu Classic			9 lbs.	7-12 lbs.	Front exterior, minus grille, bumper and lights.	3 PL 4 MI	WAW 3/78 p. 115 AI 10/1/77 p. 24
Front and Rear Ends		F	1979	Mustang III	Plastic			200 lbs. less		1F	WAW 4/78 p. 9

FIGURE 6-6. COMPONENT WEIGHT CHANGES - BUMPERS (Concluded)

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MEO. REF. BOOK NO.	ORIGINAL REFERENCE
CYLINDER BLOCK											
Cylinder Block					Thin wall castings			3 lbs. per block by analysis		4 ED	AI 7/1/77 p. 33
Cylinder Block		F			Al			25-30 lbs. per cylinder (over cast Fe)		4 ED	AMM 6/13/77 p. 37
Cylinder Block		C	by 1980	optional	Al			50 lbs. less	318 CID V-8	4 ED	WEU 6/10/77 p. 1
Cylinder Block		C	3-4 yr.		Thin wall cast iron	614 lb(V-8) 542 lb(V-6) (all Fe)		70-120 lbs. 105 lbs.	318 CID V-8 225 CID V-6	4 ED	WEU 6/10/77 p. 1
Intake Manifold					aluminum						
Water Pump					aluminum						
Cylinder Heads		F			Al			52 lbs. (5L, V-8 engine)	Research stage 26 lb Fe can be replaced by 11 lb. Al	4 ED	AE 1/78 p. 32
Block					Composite: Molding Material Compound Containing Lacquer			60-65% less than cast iron 30-35% less than Al	experimental	4 ED	AE 3/78 p. 7
CLUTCH											
Stamped					Stamped instead of Cast			11.88 lbs. (5.4 kg)	Lipe-Rollway Corp.	4 ED	AE 3/78 p. 22

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
BELL HOUSING											
Stamped Steel bell housing					Stamped Steel (n) Cast Iron (O)	49 lbs.	30 lbs.	(19 lbs.) 14 lbs.		4 EO 4 ED	AI 7/1/77 p. 33 AI 12/1/77 p. 49
Connecting Rods											
Composite					Fiber-reinforced Composite (n) Al (O)		400 9	40% less	Small-block Chevy V-8 racing cars.	4 EO	AE 3/78 p. 7
Control Devices											
EEC II		F	1979	Marquis (Std) LTD (Calif)				55% less wt. than EEC I	Package size down 40% # parts down 30%	4 EO	WAR 4/17/78 p. 123

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Continued)

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
ENGINE DESIGN											
Engine cover plates (rear)		F	1978	200 & 250 CID 6-cyl.	Al 2056		1.1 lbs. (manual trans) 0.92 lb. (auto)	1-2 lbs.		4 ED	WEU 2/3/78 p. 7
		F	1979	140 CID 4-cyl.			0.55 or 0.48 lbs.			4 ED	AMM 12/19/77 p. 11
				302 CID 8-cyl.			1.1 lbs or 0.85 lb				
		F	eventually all engines								
4-cylinder engine		GM	1978		Al	330 lbs			discontinued	4 ED	WEU 9/16/77 p. 5
V-6 engine		GM	1978	Chevy pick-up				80 lbs./ engine less		4 ED	AN 10/3/77 p. 8
V-6 engine		GM	1978	Chevy Malibu				63 lbs.less than '77	200 cu in.	4 ED	WEU 9/16/77 p. 4
Engine (V-6)		Porsche Mercedes Benz		928 450 SLC Coupe	Al with Silicon			200 lbs. from U.S. cast iron	includes dry engine, radiator, accessories.	4 ED	WEU 6/10/77 p. 8

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Continued)

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	'ORIGINAL REFERENCE
DIESEL ENGINE											
Diesel Engine		GM	1978	Olds			728 lbs.	111-130 lbs. more	350 CID V-8 gas engine	4 ED	WEU 9/16/77 p. 4
										4 ED	MT 10/77 p. 84
								180 lbs. more	gas engine of equal power	4 ED	R&T 11/77 p. 63
										4 ED	MT 5/77 p. 19
DRIVETRAIN											
Front wheel drivetrain		GM	1977	Olds Toronado		6.8 lbs.	4.8 lbs.	Transfer case: 69 lb.(single assembly) 105 lbs. (double)	Morse chain new design	4 ED	AI 7/1/77 p. 33
4-wheel drivetrain		A		Jeeps	Al(n) Iron (O)	210 lbs.	100 lbs.	110 lbs.	Option	4 EO	AI 7/1/77 p. 33
Rear axle hypoid gears		GM	Jan. 1977	Full size Wagons, Cadillacs	Iron			2 lbs. (over steel)	Pontiac gears	4 EO	WAR 10/17/77 p. 331
Rear axles		F	1978	Fairmont/ Zephyr				9-28 lbs. less per car (F/Z)	Redesigned	4 ED	WAR 9/26/77 p. 308
		F	1979	Standard models							
Driveshaft and leaf spring		F	1976	Granada	Graphite Fiber	28 lbs. (steel)	4.5 lb. fiber	84%		4 EO	AI 7/1/77 p. 33

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Continued)

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	•ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
TRANSMISSION CASE											
Al trans-mission case		GM	1977	Pontiac Astre	Al		65 lbs.		Warner Gear T-50 5-speed, manual	4 ED	AI 7/1/77 p. 33
							93 lbs.		151 CID, 4 cyl. auto	4 ED	AI 7/1/77 p. 33
Al trans-mission case		F	1974	Mustang II	Al		58 lbs.		SR-4, 4-speed, manual	4 ED	AI 7/1/77 p. 33
Al trans-mission case		A	1977	Pacer/Hornet/ Gremlin	Al			20 lbs. less	SR-4 speed optional vs. 3-speed	4 ED	AI 7/1/77 p. 33
Al Trans-mission case		GM	1977	Chevy Corvette Camaro Pontiac Trans-Am	Al		70 lbs.		T-10 4-speed, manual	4 ED	AI 7/1/77 p. 33
Cast iron transmission case		GM	1957	Chevy Corvette	Cast Fe	85 lbs.			T-10 4-speed, manual	4 ED	AI 7/1/77 p. 33

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Continued)

COMPONENT WEIGHT CHANGES

ENGINE/DRIVETRAIN PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
INTAKE MANIFOLD ~~Intake~~ Manifold		GM	1978	260, 350 CID V-8 200 CID V-6	Al			31 lbs.(350 CID V-8)		4 ED	AI 12/1/77 p. 47
		GM	1979	Chevy 305 V-8 Chevette	Al			25 lbs. per car over cast Fe	Designed for Dualjet 210 carburetor. Replaces Al intake manifold introduced in 1978 Chevy	4 ED 4 ED 4 ED	WEU 12/23/77 p. 1 AMM/MN 12/19/77 p. 29 AMM/MN 12/12/77 p. 13
Intake Manifold		C	1978	Volare/Aspen 6 cylinder	Al alloy 380	20 lbs. each (cast iron)	5-3/4lb each	12 lbs. on 4-door model 2/3 lighter	some models made from recycled scrap	 4 ED 4 ED	WAW 4/78 p. 64 AMM/MN 12/12/77 p. 13 WEU 12/23/77 p. 1
		C	1978	Omni/Horizon 4 cylinder						4 ED 4 ED 4 ED	AMM/MN 12/19/77 p. 29 WEU 9/16/77 p. 3 AMM/MN 7/18/77 p. 12
		C	1979	318 V-8				20-30 lbs.		4 ED	AI 12/1/77 p. 47
Intake Manifold		F	1978	Granada, Monarch	Cast Al	45 lbs. (Cast Fe)	15 lbs. (Al)	30 lbs.	some models 302 V-8	4 ED 4 ED	AMM/MN 8/29/77 p. 18 AI 12/1/77 p47
		F	1979	Standard Size	Al			40% less		4 ED 4 ED	AMM/MN11/21/77 AMM/MN 6/13/77 p. 37
			1980's		2 piece Al			2-3 lbs. less than Fe		4 ED 4 ED	AMM/MN 4/25/77 p. 13 AMM/MN 12/19/77 p. 29

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Continued)

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ENGINE/DRIVETRAIN PARTS COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
ROCKER ARMS											
Rocker Arms		F	by 1979 or 1980		Stamped Steel			Lighter than Cast Steel		4 ED	WEU 9/16/77 p. 3
FUEL SYSTEM											
Fuel system					Plastic-valox 420			lightweight	Norlyn Mfg. Ltd (Canada) Controlled pressure induction sys.	4 ED	AN 2/27/78 p. 8
MAGNETS											
Permanent Magnets					Cobalt			33% reduction in motor size and weight	H.K. Porter Co.	4 MI	AMM 2/28/78 p. 10
Magnets for: A/C blowers, windshield wiper motors, rear defoggers, distributer, heater blowers					Cobalt (n) Ferrite (o)			lower weight	Research by auto mfg. & suppliers	4 MI	AMM 2/28/78 p. 10
OIL PAN					Fiber-reinforced plastic sheet (stamped)			50% less than steel	Prototype Allied Chemical Corp.	3 PL	AMM/MN 2/20/78 p. 14

FIGURE 6-7. COMPONENT WEIGHT CHANGES - ENGINE/DRIVETRAIN PARTS (Concluded)

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COMPONENT WEIGHT CHANGES

FUEL TANK

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
Fuel Tank					HDPE (high density polyethylene)	20 lb. (steel)	13 lb. (HDPE)	7 lb. (40%)	Phillips Petroleum	4 MI	AI 12/1/77 p. 76 Advertisement
Fuel Tank		F	1978	8-cyl. Mustangs some trucks	Plastic			40% less than steel.		4 MI	WAR 1/2/78 p. 5
		C	1977	Vans, B100, 200, 300					24.7%		
		C	1977	Ramcharger, Trail Dusters.					49.1%		
		C	1977	Light conventional trucks.					86.6%		
		A	Future	Cherokee C-J Jeep Passenger Cars					Jeeps before cars.		
		GM							None yet.		
Fuel Tank					Plastic - HDPE		(36 gal.) 21 lbs. including metal components.	30% less than conventional metal.	Libbey-Owens-Ford Plastics, Inc.	4 MI	AI 1/1/78 p. 67

FIGURE 6-8. COMPONENT WEIGHT CHANGES - FUEL TANK

COMPONENT WEIGHT CHANGES

MAJOR BODY PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. BOOK	REF. NO.	ORIGINAL REFERENCE
HOODS												
STEEL												
Mild Steel Hood		F	1979	Downsized Mercury Marquis	Conventional steel				Cancelled Al Hoods Cost Factors	4	DP	AMM/MN 12/19/77 p. 17
High Strength Steel		C	1978	Omni/ Horizon	HSS outer panel mild steel inner panel		25lbs/ panel	3.7 lbs./ panel	Gauge reduction 1 lb. lost by removing reinforcement	3	ST	AMM/MN 3/6/78 p. 10
ALUMINUM												
Aluminum Hoods		F	1977½	Versailles	Al		24 lbs.	42%		3	ST	WAW 4/78 p. 63
								13 lbs.		4	BP	AI 12/1/77 p. 37
										4	BP	AMM/MN 4/11/77 P. 24
Al Hoods		GM	1977½	Olds, Std Size Cadillacs	Al					4	BP	AMM/MN 4/25/77 p. 14
Aluminum Hoods		GM	1978	Buick Intermediate (optional)	Al alloys 6009 and 6010, 5182 - SSF			50% less than steel 50 lbs.	Al on models with options. Steel standard on Regal.	4	8P	AMM/MN 4/25/77 p. 14 PS 9/77 p.87
Aluminum Hoods		GM	1978	Pontiac Grand Prix	Outer panel Al 6010 (1st use on autos) Inner panel Al 5182.			lower weight	Models with special equipment. Tooling same as for conventional steel.	4	BP	AMM/MN 12/5/77 p. 47
Aluminum Hoods		GM	1978	Olds Cutlass (optional)	Al alloy 2036			27.73 lbs. less than steel	On models with extra options and in California	4	BP	AMM/MN 1/30/78 p. 11

FIGURE 6-9. COMPONENT WEIGHT CHANGES - MAJOR BODY PARTS

COMPONENT WEIGHT CHANGES

MAJOR BODY PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
PLASTIC											
Redesigned Hood		GM	1980-1982	Corvette	Reinforced Plastic			10 lbs.	New design: eliminate conventional hood inner reinforcements	4 PL	AN 2/27/78 p. 20
DOORS											
Window Bracket		F	1977	LTO II, Cougar XR 7	Plastic	1-3/4 lbs. each (steel)	1½ lb. each (acetal	1¼ lb. each (5 lb/car)	Celanese Corporation	4 MI	AI 12/1/77 p. 134 Advertisement
										4 MI	AN 1/31/77 p. 7
Rear Doors		GM	1978	Chevy Intermediate				36.6 lb./coor	Thinner door [change in window regulator]	4 MI	AI 10/1/77 p. 24
Door					SMC (fiberglass reinforced sheet molding compound)			43%	Owens-Corning developed.	4 BP	WAW 10/77
										4 BP	Advertisement AN 5/30/77 p. 8
						66 lb. (steel)	37 lbs.	29 lb/door	Compact (2700-3600 lbs.)	4 BP	AI 3/15/77 p. 36
Door Beams		GM	1978	Intermediate	Stamped HSLA steel			lower weight		4 BP	AMM/MN 8/22/77 p. 12
		F	1978	Fairmont/Zephyr						4 BP	AMM/MN 8/22/77 p. 12

FIGURE 6-9. COMPONENT WEIGHT CHANGES - MAJOR BODY PARTS (Continued)

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COMPONENT WEIGHT CHANGES

MAJOR BODY PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
Doors Pillars Deck Lids		G		Prototype	Hi-Form 80d Steel (no alloys)			30% less than plain carbon steel	Thermo-mechanical treatment	3 ST	AMM/MN 2/13/78 p. 18
FRAME											
Frame		F	1978	Fairmont/ Zephyr	HSLA steel				Similar to AMC	4 BP	AMM/MN 5/27/77 p. 11
		A	1977	Hornet Gremlin	HSLA steel			3.44 lb./car in sill area		4 BP	AMM/MN 6/27/77 p. 11
Frames		GM	1977	B, C Body	HSLA steel			60 lb.		4 BP	Al 11/1/77 p. 37
Frame		GM	1978	A Body	HSLA steel		207 lb.	70 lb.		4 BP	AI 11/1/77 p. 37
										4 SS	Al 11/15/77 p. 19
Frame		F	1979	Ltd Marquis (downsize)	HSLA Steel SAE 950X, 950 XK			30% less than conventional steel		3 ST	AMM/MN 3/27/78 p. 5
DECK LID											
Deck Lids		GM	1978	Monte Carlo, Buick Regal	Al	70 lbs.	24 lbs.	46 lbs.	Models with extra options	4 BP	AMM/MN 7/25/77 p. 1 AMM/MN 6/20/77 p. 15
										4 BP	Al 12/1/77 p. 26

FIGURE 6-9. COMPONENT WEIGHT CHANGES - MAJOR BODY PARTS (Continued)

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COMPONENT WEIGHT CHANGES

MAJOR BODY PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
FENDER											
Fender Liners		GM	1978	Chevy and Buick Intermediates Cadillacs	Plastic (N) Steel (O)		7 lbs/ liner	10 lbs./car	Smaller size part and new material	4 BP 4 BP	AMM/MN 8/1/77 p. 5 WAW 4/78 p. 64
Front Fender Skirts		GM	1978	Chevy Intermediate	Plastic			8.6 lbs.		4 MI	AI 10/1/77 p. 24
SHEET METAL											
Sheet Metal		C	1978	Charger				3 lbs.			
		C	1978	Aspen/ Diplomat				6.5 lbs.		4 MI	AN 11/7/77 p. 38
		C	1978	Aspen Wagon				9.7 lbs.			
Electro-Coating Primer Paint		F	1978	15 of 21 plants	Paint, Zinc Phosphate for Adhesion		6 lbs paint per car		Corrosion-resistance	3 PA 3 PA	AN 1/9/78 p.13 WAW 1/78 p.54

FIGURE 6-9. COMPONENT WEIGHT CHANGES - MAJOR BODY PARTS (Continued)

COMPONENT WEIGHT CHANGES

MAJOR BODY PARTS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.		ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL				
Tailgate on Station Wagon		GM	1978	Demonstrated on Chevy Caprice	Fiberglass-reinforced plastic	46.2 lbs.	27.5	36% saved	2 piece FRP versus 6 piece steel development stage by computer analysis	3	PL	WAW 3/78 p. 134 AN 2/27/78 p. 8 AMM/MN 2/20/78 p. 14
WINDOWS												
Thinner Glass		GM	1978	Intermediates	Glass			15 lbs/car		3	PL	WAW 3/78 p. 59
Plastic Windows			1979		Coated Plastic			30% less than glass on similar gages	Replace glass - General Electric	4	MI	AN 4/3/78 p. 29
										4	BP	WAR 11/26/77 p. 379
BODY PANELS Plastic panels via in-mold coating		GM	BY 1980	Corvette	Compression molded plastic; increase glass content, glass bubble fibers, (n) partially replace talc fillers			over 90 lbs. saved	Expand use in-mold coating to all exterior body panels	3	PL	AN 2/27/78 p. 20
										3	PL	AMM/MN 8/15/77 p. 5

FIGURE 6-9. COMPONENT WEIGHT CHANGES - MAJOR BODY PARTS (Concluded)

COMPONENT WEIGHT CHANGES

TIRES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
RADIAL TIRES											
Conventional		GM	1977	B-Cars	(Conventional materials: steel or fiberglass belts)			2-2½ lbs.	F, G, H tires. smaller tread w/o reducing performance.	4 TI	AI 5/15/77 p. 27
Conventional					Conventional steel or aramids	15.5-19 lbs. per tire			Wt range for 23 tires: size 165 SR-B.	4 TI	R&T 10/77 p. 78
Radial tires		GM	1978	Intermediate				16-20 lbs. per car.	Smaller size.	4 TI	AI 12/1/77 p. 100
Fiberglass belted			1978	Some models	Fiberglass belted.			10-14% less than steel belted.	General Tire	4 TI	AN 11/21/77 p. 32
Fiberglass belted		GM	1978	6-cyl. B-Body	Fiberglass belted.						
		A	1978	Some A-Body				1 lb/tire less than steel.		4 TI	AI 12/1/77 p. 100
		C	1978	Some Models							
COMPACT SPARE											
Compact Spare Tire		GM	1978	Intermediate				13-22 lbs. per tire.		4 TI	AI 12/1/77 p. 100
Compact Spare Tire		GM	1978	Intermediate				40% lighter	Firestone "Tempa-spare"	4 TI	MT 12/77 p. 20

FIGURE 6-10. COMPONENT WEIGHT CHANGES - TIRES

COMPONENT WEIGHT CHANGES

TIRES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
COMPACT SPARE											
Compact Spare Tire Cont.		GM	1978	Inter-mediate				11-14 lbs. (30%) < regular	Firestone	4 TI	AI 5/15/77 p. 14
		F	1978	Compacts				15-20% < folding tire with inflating gas.	Uniroyal General Goodyear	4 TI	AI 5/15/77 p. 14 WAR 8/29/77 p. 276
LIGHTWEIGHT SPARE											
Light-weight Spare Tire								Wt. reduce	Goodyear	4 TI	AI 5/15/77 p. 27
ELLIPTICAL											
Elliptical tires		F	1979	Mustang Capri (option)				Same	Goodyear	4 TI	WAW 1/78 p. 60
										4 TI	WAR 8/1/77 p. 245
NON-FLAT SPARE											
Non-Flat Spare Tire								7½ lbs. less	Goodyear	4 TI	AI 5/15/77 p. 27
Non-Flat Spare Tire								4" shorter car several hundred lbs. lighter (w/o spare & jack)	Rocker	4 TI	AN 7/11/77 p. 16
UNITIZED											
Unitized Tire					Elastomeric structure with chemically bonded integral metal hub. No metal wheel.			"Significant reduction"	Zedron, Inc. Unitized pneumatic tire assembly	4 TI	AI 9/1/77 p. 54

FIGURE 6-10. COMPONENT WEIGHT CHANGES - TIRES (Concluded)

COMPONENT WEIGHT CHANGES

WHEELS

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. BOOK	REF. NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL				
STEEL WHEELS												
Wheels					HSLA	25 lb.	14-15lb.		US Steel Conventional Tooling	4	GE	WAR 8/29/77 p. 274
Wheels		GM	1978	Inter-mediate	Conventional (Plain carbon steel)			11-14 lb/car	Smaller wheel 14" not 15".	4	TI	AI 12/1/77 p. 100
Wheels & Tires		GM	1978	Chevy Inter-mediate				27 lb.	Size change from 15 into 14 inch.	4	MI	AI 10/1/77 p. 24
Wheels					GM 980X HS Steel			May be close to Al.	Experimental - may compete with Al.	4	WH	AMM/MN 2/6/78 p. 15
Wheels		GM	1979	Eldorado Toranado Riviera	HSLA Steel			10% saved		4	WH	AN 3/27/78 p. 6
ALUMINUM WHEELS												
Wheels		C	1979	R-Body	Fabricated Al	20-25 lb. (steel)	10-12 lb. (Al)	40% or 50 lb. per car full size.	Kelsey Hayes w/Reynolds	4	TI	AE 5/77 p. 15 AI 12/1/77 p. 103 WAW 10/77 p. 88 AI 5/15/77 p. 32
Wheels					Fabricated Al 5454	1½ lb. steel	1 lb. Al.	Save 2¼ lbs. per car for each 1 lb. Al used. (3/4 lb. indirect) Total 40-60 lb. per car.	Alcoa also devel-oping.	4	TI	AI 4/1/77 p. 119 AI 4/1/77 p. 120
Wheels		C	1978	Dodge Monaco, Magnum XE	Cast Al radial fin attached to steel base wheel.			not signifi-cant	Not inexpensive	4	TI	AI 12/1/77 p. 103

FIGURE 6-11. COMPONENT WEIGHT CHANGES - WHEELS

WHEELS

COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.		ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL				
Wheels					Al	25 lb.	12-14 lb.		U.S. Steel Rept.	4	GE	WAR 8/29/77 p. 274
PLASTIC WHEELS												
Wheels			long term		Sheet Molding compound (SMC)				Owens-Corning	4	TI	AI 12/1/77 p. 102
Wheels			by 1980		Fiberglass reinforced plastic (FRP)			up to 50% 120 lb. on standard size car.	Owens-Corning study cost competitive w/styled Al.	4	TI	AI 12/1/77 p. 102
Wheels			1977	Citroen SM	Fiber glass composite				Michelin	4	TI	AI 12/1/77 p. 102
MISCELLANEOUS												
Inflatable Jack					Mesh and plastic coating.				Inflates w/exhaust gas. 2 versions: lift 6,000 lb. or 3,200 lb.	4	MI	AN 2/20/78 p. 16
GLASS WHEEL												
Wheels		GM	1980's	Corvette	Glass			10 lbs.	spare, under consideration	3	PL	AN 2/27/78 p. 20

FIGURE 6-11. COMPONENT WEIGHT CHANGES - WHEELS (Concluded)

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
Water pump		F	1979	V-8 engines w/options standard size line. Ford LTD line. Mercury, Marquis line.	Al (n) die cast Cast Fe (o)	13½ lbs.	5½ lbs.	8 lbs.	Kingsbury Machine Co.	4 PA	AMM/MN 4/25/77 p. 13
POWER STEERING											
Gear Housing		F	1978	Fairmont-Zephyr	Al (n) Grey iron (o)	11 lbs.	6 lbs.	5 lbs.		4 PA	Boston Globe 3/26/78 p. H1
Rack & Pinion Power Steering Pump		F	1978					5 lbs.	Variable Ratio Design	4 PA	AE 10/77 p. 37
One Piece Steering Column		GM	1978	Full-size Mid-size	Injection molded glass-filled nylon	1.2 (Al)	0.6	0.6 (50%)		3 PL	MT 2/78 p. 64
Alternator					Stamped steel.			10% less than Al housing cast.	U. S. Steel	4 PA	AE 10/77 p. 5 Advertisement

FIGURE 6-12. COMPONENT WEIGHT CHANGES - POWER ACCESSORIES

4/30/78 CTP-MCI Page 1 of 1

SUSPENSION AND STEERING

COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
LEAF SPRING											
Leaf Spring					Glass Reinforced Plastic (n) Steel (o)	30 lbs.	7-9 lbs.	21-23 lbs. less	Development stage. Owens Corning Fiberglass Corp.	4 SS	AN 8/15/77 p. 16
Rear Leaf Spring		GM	1980's	Corvette	Fiberglass and Graphite			30 lbs.	Under consideration	3 PL	AN 2/27/78 p. 20

FIGURE 6-13. COMPONENT WEIGHT CHANGES - SPRINGS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
SEALED BEARINGS											
Sealed Bearings		F	1978	Fiesta				lighter		4 MI	AN 7/11/77 p. 18
										4 MI	AI 7/1/77 p. 22

FIGURE 6-14. COMPONENT WEIGHT CHANGES - BEARINGS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
FASTENERS											
Fasteners		F	Not in production yet.		Steel	1 lb.= 33 M8-16	1 lb.= 44 M8-16		Redesign: smaller mass but stronger.	4 FA	AI 5/1/77 p. 47

FIGURE 6-15. COMPONENT WEIGHT CHANGES - FASTENERS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %)			NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
						OLD	NEW	DIFFERENTIAL			
RADIATOR											
Copper Radiator			Prototype		Copper and brass.			80% less than conventional solder wts.	Marston Radiators (England)	4 MI	AMM/MN 6/13/77 p. 41
								50% less brass blank weight.		4 MI	AE 7/77 p. 23
Radiator Support		GM	1980's	Corvette	Glass			15 lbs.	Under Consideration	3 PL	AN 2/27/78 p. 20

FIGURE 6-16. COMPONENT WEIGHT CHANGES - RADIATORS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
ROOFS											
Roofs		All	1977	Optional on models listed	Special Glass hatch roofs.			Adds 50 lbs. per car.		4 RO	AI 3/15/77 p. 18

FIGURE 6-17. COMPONENT WEIGHT CHANGES - ROOFS

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COMPONENT WEIGHT CHANGES

COMPONENT CHANGE	CHANGE TYPE	AUTO MFGR.	MODEL YEAR	MODEL	MATERIAL	WEIGHT (lbs. or %) OLD	NEW	DIFFERENTIAL	NOTES	MED. REF. BOOK NO.	ORIGINAL REFERENCE
SEATS											
Plastic Seats		GM	1978½	Corvette special models	Plastic (small wire retainer is only metal part).		12 lbs.	24 lbs./car over metal. 50%.		4 SE 4 SE	AI 3/78 p. 11 WAR 2/27/78 p. 67
		GM	1979	Corvette (all)						4 SE	WAW 1/78 p. 45
										3 PL	MT 3/78 p. 10
SEAT BELT											
Automatic		GM	1978½	Chevette				Add 10 lbs. (2 pt. sys.)	Add 6-7 lb. if 3 pt. system	4 MI	AI 3/78 p. 5

FIGURE 6-18. COMPONENT WEIGHT CHANGES - SEATS

Typical Weight Savings With Plastic Components

Part	Material	Weight Savings	Approx. Plastic Part Wgt.
Timing Belt Cover	Vydyne® R-220 Nylon Resin	60% lighter than sheet steel	12 oz.
2-part Truck Grille	Lustran® ABS Plating Grade 299	50% lighter than zinc die-cast	Top—16 lb. 5 oz. Bottom—11 lb.
Cowl Vent	Vydyne R-220 Nylon Resin	30% lighter than steel	1 lb. 10 oz.
License Plate Pocket	Vydyne R-220 Nylon Resin	50% lighter than zinc die-cast	12 oz.
Rear Close-out Panel	Vydyne R-220 Nylon Resin	50% lighter than zinc die-cast	1 lb. 9 oz.
Instrument Cluster Panel	13% Glass-filled Lustran ABS 244	About 30% lighter than sheet steel	6 lb. 8½ oz.
Moon-roof Sun Shield	Lustran ABS HR-850		3 lb. 4 oz.
Sun-roof	Lustran ABS HR-850		1 lb. 8 oz.

Source Monsanto Plastics & Resins Co.

REFERENCE: AI 12/1/77, p. 23

FIGURE 6-19. COMPONENT WEIGHT CHANGES - MISCELLANEOUS COMPONENTS

APPENDIX A. MATERIALS WORKSHEETS

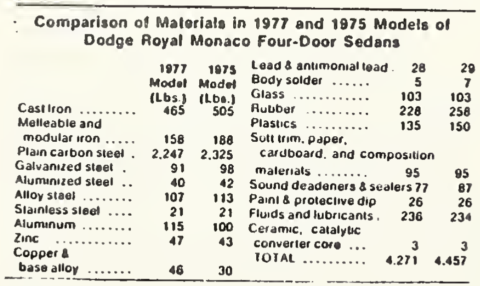
GENERAL MIX MATERIALS WORKSHEET CTP - MCI 1/16/78 GE page 2

Material	Process	Notes	Supplier	Auto Mfg.	Cost	Media Ref. Book	Ref.
Copper-based	Automated production line and one step soldering	New radiator design matches simplicity and cleanliness of all-mechanical assembly with copper's advantages in corrosion resistance and thermal/aerodynamic performance capabilities. Washing prior to painting finished radiator is made unnecessary by use of a non-corrosive low-residual flux. Process also permits standardization of parts.	Marston Radiators (England)		Production cost 15% less. Indirect savings in heating fuel and water. 35% labor less.	3 GE	AE 7/77 p. 23
Copper		Downsized models use smaller radiators so less copper used in cars. About 30 lbs./car copper. Pontiac Catalina 1977: 14.3 quart radiator Pontiac Catalina 1976: 21.3 quart radiator 1978: smaller Ford Fairmont and Mercury Zephyr Chrysler Dodge Omni and Plymouth Horizon		GM Ford Chrysler		3 GE	AMM/MN 7/25/77 p. 5
Glass		Modest boost in per car consumption in 1978. Although the trend toward thinner, lightweight glass continues, windows, backlights and windshields of some cars are larger than normal for increased visibility, and more glass sunroofs are offered. On 2-door Fairmont 33% more total glass area than 1977 Maverick. Chevy Corvette--wraparound backlight, lift-out roof panel.		Ford GM		3 GE	WAW 9/77 p. 46

FIGURE A-1. GENERAL MIX MATERIALS WORKSHEETS

GENERAL MIX MATERIALS WORKSHEET

CTP - MCI 1/16/78 GE page 1

Material	Process	Notes	Supplier	Auto Mfg.	Cost	Media Ref. Book	Ref.
				Chrysler		3 GE	AMM/MN 1/10/77 p. 13

Comparison of Materials in 1977 and 1975 Models of Dodge Royal Monaco Four-Door Sedans

	1977 Model (Lbs.)	1975 Model (Lbs.)
Cast Iron	465	505
Melleable and modular iron	158	188
Plain carbon steel .	2,247	2,325
Galvanized steel .	91	98
Aluminized steel ..	40	42
Alloy steel	107	113
Stainless steel	21	21
Aluminum	115	100
Zinc	47	43
Copper & base alloy	46	30
Lead & antimonial lead .	28	29
Body solder	5	7
Glass	103	103
Rubber	228	258
Plastics	135	150
Soft trim, paper, cardboard, and composition materials	95	95
Sound deadeners & sealers	77	87
Paint & protective dip	26	26
Fluids and lubricants .	236	234
Ceramic, catalytic converter core ...	3	3
TOTAL	4.271	4.457

FIGURE A-1. GENERAL MIX MATERIALS WORKSHEETS (Concluded)

ADHESIVES

AUTO MFG.	ADHESIVE SUPPLIER	ADHESIVE	NOTES	MEDIA REF. BOOK NO.	REFERENCES
	Avery International Fasson Division Painsville, Ohio		Gary A. Davidson, Manager of Marketing Services: The company foresees a 30%/yr. growth in replacing mechanical fasteners with adhesives. This push is especially strong due to automakers' drive to cut costs and weight.	3-Ad.	AMM/MN 6/20/77 p. 21 '
			Applications - auto side trim, gaskets and dashboards. Replaces rivets, small screws and clips in plastic-to-metal applications.		
GMC Fisher Body Division			Conducting metal-to-metal adhesives research.		
			Industry is at "show me" stage. Primarily non-standard systems for special applications.		
		Acrylic Resin	One type of Fasson adhesive.		
		Natural or Synthetic Rubber	2nd type of Fasson adhesive.		
			Application of adhesives is crucial to their success. Therefore, Fasson also makes their own adhesives application machinery.		
			Little or no market penetration expected in the following areas: 1. bolt-and-nut business where disassembly is necessary. 2. welding applications (structural)		
	Goodyear Structural Adhesives Division Ashland, Ohio		Working on adhesives for the '80's. A major deterrant to use of structural plastics in autos is the ability to maintain a class 'A' finish in plastic parts without an extensive amount of labor.	3-Ad.	AI 7/15/77 p. 36
			New materials reduce weight but don't lend themselves to conventional fastening methods.		
	Goodyear		Is working on a systems approach to bonding, i.e., including adhesive systems as an integral part in all decisions made during development and production such as selection of substrates, design of the part and setting up the assembly operation.	3-Ad.	AI 7/15/77 p. 36
			Preplanning - testing and specification of bonding and adhesive system: 1. physical properties as related to specifications. 2. evaluation of resistance to environmental degradation. 3. evaluating adhesion characteristics of potential systems. 4. durability testing.		

FIGURE A-2. ADHESIVES WORKSHEETS

Aluminum Worksheet CTP - KD 11/14/77 AL page 1 & 2

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Ford		Semi-permanent Mold casting	Al intake manifolds; Weight savings is 25-30 lbs./car.	3 AL	AI 5/1/77 p. 13
		Die Casting	Need to redesign manifold to manufacture them via die casting.		
Ford		Permanent Molded	Al brake master cylinder - 1979 MY 2-3 lb. weight savings.	3 AL	AI 5/1/77 pp. 12, 13
		die cast	Al rear wheel brake drum--introduced "in the next few years" with cast iron liners and steel drum back. Weight savings: 5 lbs. compact car; 15 lbs. full-size car.		
		die castings	Al power steering pump housing MY 1978 1.5 - 2.5 lbs. savings.		
			Al rack and piston steering gear housing some MY 1978 models (not named). Wt. savings of 3-4 lbs.		
			Short term answer - semi-permanent moldings Long term answer - die casting		
			Al castings are 3% of 1977 Ford car, or 110 lbs. Cast iron is 16% of 1977 Ford car, or 620 lbs.		
			Cost - factor of 2 on a substitution basis with cast iron.		
			Facilities - costly casting facilities. Risk of idling iron casting facilities.		
			Al pricing and supply - major shift to Al will have a significant impact on short term availability of aluminum.		

FIGURE A-3. ALUMINUM WORKSHEETS

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
	Alcoa		Alloys 6009 and 6010 will replace 2036-T4 and 5182-0. 2036-T4 and 5182-0 inner/outer panel combination are not compatible for scrap. 6009 and 6010 are compatible. At T-6 temper,(i.e. after a paint bake cycle of 30 min. at 400^{o}F) yield strengths are above most body sheet steels. At T-4 temper - good formability. Can produce commercial quantities of 6009/6010 next spring.	3 AL	WAW 12/76 p. 71
G.M.	Alcoa		Working on the all Al hood.		
	Alcoa	661	Z-7046 experimental alloy - for bumpers - 661 process: pre-treatment of chronium plated Al bumpers (non cyanide method) offered royalty free to encourage switches to Al bumpers.		
			6009-T4 and 6010-T4 for body sheet applications. Provide optimum combination of strength and formability in the "as received" T-4 condition with the ability to increase in strength considerably after a paint bake treatment. Advantages: (1) Excellent formability; (2) higher strengths after baking; (3) Improve corrosion resistance, spot weldability and surface appearance while maintaining equal finishing characteristics; (4) Promise of replacing steel parts with substantial cost savings due to high scrap value and lighter guage.	3 AL	AE 5/77 p. 48

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77 AL page 4

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Ford			Al cylinder heads and blocks being considered by Ford. Other potential applications--rear axle carriers, rear wheel brake drums, variety of steering components. (To be phased in over 10 years.)	3 AL	AMM/MN 6/13/77 p. 37
			1985 - Ford expects to double al usage/car to 200-250 lbs/car.		
		semi-permanent mold casting	Short term usage to meet design constraints		
		die casting	long term because of economic advantages, e.g. less machining and lower capital investment costs.		
		die casting	two-piece single plane intake manifold could be ready for pdn by early 80's. 2 - 3 lbs. wt. savings.		
			Al cylinder heads would be phased in on the molding equipment when manifolds are die cast. Wt. savings = 25-30 lbs/cylinder		
		die cast	Al cylinder blocks - requires 2500 ton and larger machines - 7 ft., 100,000 lb.cube for a V8/5.0 l. engine.		

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77 AL page 5

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Ford			Components converted to aluminum: partial rear seat back panels (some wagons) models listed. Mercury wagon: This assembly includes (1) inner and outer panels supporting the back of the rear seat, (2) Transmission panels between the seat and the load floor, (3) load floor/storage compartment cover, (4) four flat auxiliary finish panels attached to the floor with screws. Stamped on conventional steel tooling joined by conventional resistance spot welding techniques (Using unique fixtures and modified cycling.)	3 AL	AMM/MN 1/10/77 p. 22
Ford St. Louis, MO San Jose, CA	Lobdell Emery Mfg. Co., Alma, Michigan	Welding & Fabrication	Final assembly done by Ford at body plants in St. Louis, MO and San Jose, CA. 1010 steel panels = 84 lbs. Al panels = 40 lbs. Seat back partials in Al Weigh 18-19 lbs. (Mercury--45-55% wt. savings realized) 1010 steel panels = 25 lbs. Al panels = 11 lbs. (Pinto/Bobcat assemblies 45=55% wt. savings realized.)		

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77 AL page 6

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Chrysler		Warm forming of high strength Al.	12-hour heat treat cycle--Al hardens but is brittle. New process allows warm forming with a 2-minute heat cycle.	3 AL	WAR 3/7/77 p. 76
	Aluminum Association		1974 - 75 lbs/car 1975 - 80 lbs/car 1976 - 87 lbs/car 1977 -100 lbs/car	3 AL	WAR 1/3/77 p. 4
G.M.	Reynolds		Al back-up bars for full size car bumpers Cargo inner doors for large station wagons Other trim items; Al hoods on Cadillac models		
G.M.	Alcoa		Al hoods on '77 Olds 88 models Al bumper - 1st major expansion of Al usage in autos. 1974 - Camaro and Vega/Astre--debut of Al bumpers; 1977 - Pinto and Bobcat; 1978 - one more line - unspecified. Al wheels will be used more extensively. Higher costs will defer wholesale swing to Al wheels until forced by 1980's standards.	3 AL	WAR 1/3/77 p. 4
Ford	Hayes-Albion		Al intake manifolds. Will begin production for Ford in March, 1978.	3 AL	AMM/MN 2/21/77 p. 4

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum WORKSHEET CTP - KD 11/14/77 AL PAGE 7

Auto Mfg.	Aluminum Supplier	Process	Book No.	References
		Average Al content in an auto = 100 lbs. Only 9% of Al industry shipments went to autos.	3 AL	WSJ, 6/13/77 p. 1
	Richmond-based Reynolds	Provides 1/2 of Big Three Al needs. Is No.2 nationwide producer.		
	Al. Co. of America	Provides 1/3 of Big Three Al needs. Is No.1 nationwide producer.		
	Kaiser Al. and Chem. Corp.	Provides 1/5 of Big Three Al needs. Is No.3 nationwide producer.		
		Fabricated Al wheels: weight savings = 50 lbs/car; cost increase = $30 to $60 tentatively planned for some '79 MY cars.		
		1975 Average car: 2.9% Al; 3.5% plastic; 61% steel. 1990 prediction: 10-24% Al; 8-17% plastic, 46-54% steel.		
		1 lb. AL in a 1977 car: Energy saved over car's lifetime is 4.8 to 7.2 times greater than energy needed to make the lb. of Al.	3 AL	WSJ 6/13/77 p. 25
		$500/ton is the price of junk Al. Recycling uses 5% of energy required to make virgin metal.		

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet

Auto Mfg.	Aluminum Supplier	Process	Book No.	References
		1978 LeMans soft face bumper systems-front and rear include an advanced concept in flexible chrome bumper moldings.	3 AL	AMM/MN 8/1/77 p. 11
		1978 Grand Prix bumper systems (HSS/Al) will weigh 100 lbs less/car.	3 AL	AMM/MN 8/1/77 p. 11
	Aluminum Association	Trade group relies on reports and statements by industry executives for long-term aluminum supply outlook. Three factors affecting Al supply: 1. bauxite, 2. energy, and 3. capital. Bauxite world supply=240 yrs. at current consumption rate. U.S. could become self-sufficient. Especially with new technology for processing non-bauxitic ores and low-bauxitic ores e.g. alunite, anorthosite, coal waste, clays, kaolin and laterite. Electricity - Alumina is smelted electrolytically. Electricity accounts for approx. 2/3 of energy used by industry. Electricity to produce one lb. of aluminum: WWII - 12 KW hours; today - 8 KW hours. 6.5 KW hours (some plants); 4.5 KW hours (pilot plant). Current ROI may be inadequate to justify further expanded capacity in the aluminum business. 10% expansion of existing capacity requires $1.0 to 1.2 bill.	3 AL	AN 7/4 25/77 p. 8

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
G.M. B-O-P			Al Rear Brake Drums '70 Buicks used for cooling efficiency. Front disc brakes made this application superfluous. '78 Intermediates - Now used for weight reduction and improved ride due to reduced unsprung weight.	3 AL	WAR 8/29/77 p. 275
Ford Sheffield, Ala.		Low Pressure Die Casting	Al Manifolds produced at Ford's Sheffield, Ala. castings plant. Conventional gravity castings also used. The two processes will be compared for costs, yield, and energy consumption. Low pressure machines - Ford/Brazil - Al cylinder heads for 4-cylinder engines.	3 AL	AMM/MN 8/8/77 p. 27
Massena, N.Y. Chevrolet Motor G.M.		Low Pressure Casting	Purchasing equipment for Massena, N.Y. plant	3 AL	AMM/MN 8/8/77 p. 27
		Low Pressure Casting	Yields = 90-95% or higher Possibility to save on tooling costs Overseas--used more extensively than U.S. Superior to conventional casting in (1)yield in the casting wt./metal poured ratio; (2) mfg. energy consumption; (3) tooling costs. Better for large parts.		
Pontiac G.M.			New Al applications: radiator supports, master brake cylinders, rear brake drums, Al bumper reinforcements, cast wheels, extruded all-Al bumpers (some models are listed).	3 AL	AMM/MN 8/1/77 p. 11

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Ford			'78 Fairmont vs. '77 Maverick-Comet 147 lbs. ← 105 lbs. plastic 114 lbs. ← 79 lbs. aluminum 138 lbs. ← 75 lbs. HSLA	3 AL	WAR 9/5/77 p. 285
British Leyland	TI Superform Worcester, England	Stamping	Aluminum Body Panels 3/74 → present--unique process. Uses sheets of new alloy "supral" (6% cu. 0.5% zirconium) which become superplastic when heated to 450°C and is then capable of ten times elongation without fracturing. After forming, Supral assumes all mechanical properties of conventional Al up to 150°C. It can be electro-plated, anodized, painted, spot/fusion welded. Auto parts: 17 different panels for Aston Martin Lagonda sedan; exhause pipe heat deflector for Lotus; acoustic panels for Perkins diesel engines; fuel tank filler cowl for a Leyland bus; prototype headlight reflector for Lucas. Forming process--most suitable for medium production runs of 100-10,000 pieces (for small runs, low tooling costs easily outweigh extra cost of special alloy and long cycle times, e.g. 5 min.). Die--only one needed: iron casting approx. \$425/ft.^{2} of plan dimensions (approx. 1/20 the figure for conventional stamping dies).	3 AL	AE 8/77 p. 18

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
	Reynolds Al.	Extrusion	Extruded face bars, front and rear: Fairmont, Pinto, Zephyr, Bobcat (all 1978's) Sheet Bumper reinforcements and brackets, front and rear (1978 models) GM "B" body Chevrolet, Olds, Cadillac, Buick, Pontiac; GM "A" body Cutlass, Grand Prix, Century, Monte Carlo, Chevelle, Ford Granada & Monarch.	3 AL	Advertisement WAW 10/77
Chevrolet GM			Vega Al engine: Introduced in 1970. Problems developed due to engine's tendency to warp when overheated causing misalignment of the head and block and a breakdown of gasket sealing. Same engine in 1977 used higher quality materials, an overflow coolant reservoir, better quality control. Was discontinued with Vega line.	3 AL	WEU 9/16/77 p. 5
Porsche			Porsche 928 - Completely new Al engine -- Bare Al cylinder walls running against iron clad Al pistons--the same technique pioneered in the Vega.	3 AL	WEU 9/16/77 p. 5
Alcoa Aluminum Corp.			Roy A. Gentles Exec. V.P.: A 1.2 million lb. shortage of Al could develop about 1980 in the U.S. No worldwide shortage is anticipated.	3 AL	AN 9/12/77 p. 34

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77 AL page 12

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
Chrysler Corp.	Kelsey-Hayes Co.	Fabricated	Fabricated Aluminum Wheels - For 1979 Chrysler R-car--weight savings=10lb/wheel Manufactured on conventional tooling. Meets requirements with respect to speed, cost, durability and performance. First application on production (pdn) car.	3 AL	WAW 10/77 pp. 87-8
	Houdaille Ind, Inc. Oshawa, Ont.		Chrome plated Al bumpers - First application on production car will be 1979 - R-cars. Provides popular bright metal finish look. Cost and technical difficulties have been overcome.		
			List of new pdn applications for Al and other lightweight materials 1973-1978	3 AL	WAW 10/77 p. 87
			1973-1978 Chrysler has reputation as an innovator in lightweight material applications		
			1977-1978 Chrysler has fallen behind competitors		
			1979 - R-car debut		
Chrysler			Future new Al applications (beyond 1979) Optional Al Cylinder head for V8/318 for MY 1980. Save 50 lbs.	3 AL	WAW 10/77 p. 88

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

Aluminum Worksheet CTP - KD 11/14/77 AL page 13

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
		Reduction Cell	Lower temperatures, insulation of cell to reduce heat loss, and additives to increase solubility 8KW/lb (old)→ 5-6KW/lb Alumina (new)	3 AL	AMM/MN 10/24/77 p. 21 (cont.)
		New Problem	Anode material - oil refining residue tends to show an increasing sulfur content.		
Ford Motor Co. Sheffield Ala. Al parts plant		Die Casting (Low Pressure)	Purchased low pressure casting for 1978 Al intake manifolds for cars with 302-cid V-8 engines. First of its kind to be used by Ford in this country.	3 AL	WEU 10/14/77 p. 8
Chevrolet & Olds GM Corp.		Sand Cast Permanent Mold Cast Al.	Purchasing sand cast and permanent mold cast Al intake manifolds for some 1978's with V-8/350 engines. Using independent suppliers rather than own facilities.		
Chevrolet Massena, N.Y. Al casting plant		Low Pressure Die Cast	Major expansion project for low pressure die casting machines (by Prince & Chromalloy Precast, St. Louis, MO).		
Auto Manufacturers			Using other than conventional casting techniques to evaluate quality and cost of alternative mfg. systems: least scrap, least energy, least manpower, greatest productivity.	3 AL	WEU 10/14/77 p. 8

FIGURE A-3. ALUMINUM WORKSHEETS (Continued)

CTP - KD 11/14/77 AL page 14

Aluminum

Worksheet

Auto Mfg.	Aluminum Supplier	Process		Book No.	References
	Martin Marietta Laboratories, Materials Dept.		John A.S. Green, Dept. Head - Industry goal = 10% energy savings. Goal is 85% complete.	3 AL	AMM/MN 10/24/77 p. 21
		Smelting	60% of energy in smelting does not go into the reduction process. Major savings possible via alteration of 40/60 ratio.		
		Dry Scrubbing (Smelting)	Balance energy and environmental demands vs. quality factors - Dry scrubbing of pot gases by running through coarse-grain alumina. Saves money via recovery of fluorides. Picks up contaminants which affect purity of high strength materials.		
		Mining	Trihydrate bauxite found closer to surface requires less energy for digestion. Monohydrate form found lower down requires more heat.		
		Alumina Refining	Trend toward fluid bed calcination and shift from rotary kilns.		
		Smelting	Use of computers to monitor and adjust anode-cathode distance.		

FIGURE A-3. ALUMINUM WORKSHEETS (Concluded)

CTP - HCI 12/28/77 CA page 1

CATALYSTS Worksheet

Materials	Notes	Supplier	Media Ref. Book	Reference
Rhodium	Most effective material found so far for the 3-way catalysts. Leading catalyst supplier, Englehard Minerals and Chemicals Corp., is under investigation for antitrust since 28.6% of it is controlled by a South African company (Anglo American Ltd.) whose holdings include Rustenburg Mines Ltd., the South African mining company which supplies 70% of free world's platinum group metals.	Englehard Minerals and Chemicals Corp.	3 CA	'WAW 7/77 p. 31
Rhodium Pellets	GM switches supplier of substrates for its catalytic converters to Degussa AG of Frankfort, W. Germany, as it begins phase-in of 3-way catalysts. 1978 California: few thousand small Buick and Pontiac 1982: All models.		3 CA	WAW 7/77 p. 31
Platinum Rhodium	Developed method of rejuvenating monolithic catalytic converters while they are on cars. Development could be significant, as mounting political and economic disruption in Africa threatens supplies of platinum and rhodium. Platinum is the active ingredient in current converters. Both platinum and rhodium will be used in 1978 converters with widening use of rhodium in later model years. Two types of current converters require replacement of metal when inoperative. 1. monolithic substrate - the material on which metal is coated - must be replaced. 2. pellets which carry the precious metal can be sucked out of their containers and replaced. In both cases, substrate and pellets go to recovery concerns, which reclaim the metal.	Colonial Metals, Inc.	3 CA	AN 6/13/77 p. 19

FIGURE A-4. CATALYSTS WORKSHEETS

CERAMICS Worksheet

CTP - MCI 1/13/78 CE page 1

Material	Process	Notes	Supplier	Auto Mfg. Models	Media Ref. Book	Ref.
		Technical specifications Corning Glass Ceramic Heat Recovery Wheels			3 CE	, Corning Glass Works Brochure WAW 6/77 p. 46
		Ford labelled inaccurate information in story (AMM/MN, Nov. 7) reporting Ford planned to test ceramic pistons in PROCO stratified charge engine, in place of aluminum pistons. No intention of dropping use of aluminum in pistons but there is a materials-related problem with the PROCO not related to the pistons.		Ford	3 CE	AMM/MN 12/12/77 'p. 17
		Developing ceramic engine rocker arms that weigh less than half that of metal rocker arms now universally used. Eaton predicts that ceramic will replace metal arms but didn't predict when. Brittleness remains a problem and Eaton working on additional strength.	Eaton Corp.		3 CE	WEU 6/24/77 p. 1
Aluminous Keatite Ceramic		Aluminus keatite ceramic developed for rotary regenerator cones in automotive and industrial gas turbine engines. Core recovers heat in exhaust gas to preheat incoming air to decrease fuel consumption and to improve engine efficiency. Advantages: (1) Essentially a zero coefficient of thermal expansion between 25-800 degree C, so able to withstand high thermal gradients. (2) Withstands attack by sulfuric acid and sodium which often led to premature failure in earlier cores. Potential production problems (hydrogen/lithium ion exchange) controlled. So called "micro cleavage" openings, spaced about 500 Angstroms apart, occur during mfg. and are collapsed during subsequent firing of the material. The openings reduce the modules of rupture by about 40% as compared with the parent lithium aluminosilicate, but the reduction is accompanies by a stiffness reduction. These factors combine to produce a substantially higher strain tolerance and a much higher strain tolerance and a much higher safety factor under thermal stress.	Corning Glass Works		3 CE	AE p. 22 4/77 AMM/MN 4/4/77 p. 33

FIGURE A-5. CERAMICS WORKSHEETS

CHROME Worksheet CTP - MCI 12/28/77 CR page 1

Material	Process	Notes	Supplier	Auto Mfg. Models	Med. Ref.	Reference
Chrome-Sputtered ABS Plastic	Vacuum Metalizing or Sputtering	Lower grilles of Caprice only production application: lower grilles of ABS plastic are placed in vacuum coating chamber and covered by chromium atoms. Testing upper grilles. Hopeful alternative to conventional electroplating; sputtering is less expensive and more efficient and expected to use less chrome and energy in production.	GM	GM '77 Chevy Caprice '78 Chevy Caprice	3 CR	AMM/MN 8/29/77 p. 2

FIGURE A-6. CHROME WORKSHEETS

IRON <u>Worksheet</u> CTP - MCI 12/28/77 FE page 1

Material	Component	Process	Notes	Supplier	Auto Mfg.	Model	Wt. Reduc.	Media Ref. Book	Ref.
Iron	Rear axle hypoid gears	Cast	New nodular iron hypoid gears comparable to steel gears in durability. Initial annual production expected to be 1.1 million gear sets.	GM	GM	Jan. '77 standard on all full-size station wagons, most Cadillacs, some others	2 lbs. saved on Pontiac gear set	3 FE	WAR 10/17/77 p. 331
Iron	Rear axle hypoid gears	Cast	Lighter, quieter, less energy intensive, less expensive to produce.	GM	GM			3 FE	AMM/MN 10/24/77 p. 5
Iron	Rear axle hypoid gears	Cast	First in auto industry for cast iron gears. Increased tool life during machining, higher strength, quieter operation and lighter weight. Cost savings: (1) greater yield per tool (a) carbon particles lubricate machines (b) annealins operation (2) no changes required in geometry to accommodate new material's properties. (3) heat treatment requires shorter time than steel gears; no quenching presses.	GM Central Foundry and Pontiac	GM	All station wagons with 8-3/4 in. rear axle.		3 FE	AI 5/15/77 p. 40

FIGURE A-7. IRON WORKSHEETS

LUBRICANTS WORKSHEET CTP - KD 11/2/77 LU p. 1

LUBRICANT MANUFACTURER	NAME OF LUBRICANT	TYPE OF LUBRICANT	NOTES	COST	GAS SAVINGS	MEDIA REF. BOOK NO.	REFERENCES
Acheson	Emralon® (PTFE) Dag® (graphite) Molydag® (MOS_2)	Dry film	Used: valve stems, cams, gas caps, ashtrays, sun roofs, solenoid plungers, 26 different parts in the carburetor Permanent lubricants. Benefits: Shrug off intermittant operating temperatures. Resist rust and corrosion. Impervious to gas, greases, oils and water.			3 LU	Advertisement Acheson.
Ford		Synthetic Oil Graphite and Molyblends	Meet company specs. (According to a Ford source. Ford is working with SAE on development of ratings.		Unquestioned	3 LU	WEU 9/30/77 p. 6
GM			Evaluating test procedures for an extended oil change interval. Not enough data yet to recommend it in owners manuals.				
Chrysler			Excited about new formulas. Haven't run dynamometer tests yet.				

FIGURE A-8. LUBRICANTS WORKSHEETS

LUBRICANTS

WORKSHEET

CTP - KD 11/2/77

LU o. 2

LUBRICANT MANUFACTURER	NAME OF LUBRICANT	TYPE OF LUBRICANT	NOTES	COST	GAS SAVINGS	MEDIA REF. BOOK NO.	REFERENCES
Atlantic Richfield Company	Arco-Graphite	Graphite enriched motor lubricant	Reduces engine wear. Turns oil black.	$1.55/qt.	increase mileage up to 8.7%.	3 LU	WAW 8/25/77 p. 25
Exxon	Uniflo		No extended drain interval or reduced oil consumption. Also does not claim reduction in engine wear.			3 LU	WSJ 8/25/77 p. 21.
	Syn 1	SAE-SW-20	Short trip: 6 miles, cold start, 40% urban 60% highway. Gas savings due to reduced friction (low viscosity), pressure-viscosity, traction coefficients. Oil economy for engines which don't leak. Extended oil drain intervals due to thermal and oxidative stability. Savings from mpg improvement overrides small increase in energy required for production. Stabilized oil pump temperatures 5-27°F cooler. Reduction in oil pressure because viscosity is lower - causes no harm. Viscosity is constant within SAE limits - less oxidation; retains original properties longer.		Ave. increase over 5%. 1 barrel of Syn. 1 is equivalent to 6.6 barrels crude oil.	3 LU	AE 6/77 p. 56
		Synthetic	Some manufacturers use it in EPA rating tests. EPA disqualifies fleets using it because it is not readily accessible to general public.		Ave. increase in mileage 4 or 5%.	3 LU	AN 9/26/77 p. 49
		Synthetic	Any synthetic engine oil must meet weight and service specifications as outlined in the owners' manual, i.e., at least SE Service grade. Temp.> 20°F → weight at least 10W-40 -- n.b. at least 1 synthetic is rated 5W-20. Warmer temp. → 20W-40 or 20W-50 - n.b. at least 1 synthetic is rated 5W-20. Synthetic oils may not mix. Should stick to one brand. Changing synthetic oil at 5,000 mile intervals according to warranty. Can prove costly:	$12.00 plus filter and labor		3 LU	RT 11/77 p. 164

FIGURE A-8. LUBRICANTS WORKSHEETS (Continued)

LUBRICANTS WORKSHEET 11/2/77 LU p.3

LUBRICANT MANUFACTURER	NAME OF LUBRICANT	TYPE OF LUBRICANT	NOTES	COST	CTP - KD GAS SAVINGS	MEDIA REF. BOOK NO.	REFERENCES
Exxon	Uniflo	Natural Oil	Super-premium 10W-40 motor oil. Exceeds car-makers requirements. 1,500 miles to condition engine. Contains Exxon's oil soluble friction modifiers for added engine efficiency and gas savings.	A little more than multi-grade oils.	Ave. = 16 mi. per tankful after conditioning.	3 LU	Sales Brochure: New Uniflow Motor Oil conserves gasoline saves money. Exxon Co. 1977
Climax Molybdenum Company		Gear with Molybdenum disulfide	Molybdenum disulfide additives can improve axle efficiency from 1% to 40%. Added to entire power train fuel efficiency could improve 10-15%. EPA will not allow this additive in certification testing because it isn't readily accessible to motorists.			3 LU	WEU 9/16/77 p. 6
Exxon USA		Motor Oil	Announces its existence (Uniflo's) See above description.		Ave. = 4.5%	3 LU	WEU 9/2/77 p. 16
Mobil		Motor Oil	Working on it - product similar to Uniflo			3 LU	WEU 9/2/77 p. 16
Atlantic-Richfield		Motor Oil	Working on it - product similar to Uniflo			3 LU	WEU 9/2/77 p. 16
Pennzoil		Motor Oil	Working on it - product similar to Uniflo			3 LU	WEU 9/2/77 p. 16
Arco		Motor Oil Graphite enriched	Intro. - mid July. Graphite turns oil coal black.	$1.55/qt.	Increase mileage 8.7%.	3 LU	WAW 8/77 p. 25
Mobil	Mobil 1	Synthetic	Meets engine warranty provisions. Manufacturers reluctant to admit it.	$3.95/qt.		3 LU	WAW 8/77 p. 25
Exxon USA	Uniflo	Motor Oil New Improved version	Based on road test data - ave. savings will be approximately 3¢/gal. of gasoline Oil-soluble friction modifiers not identified.	$1.40/qt.	Ave. increase in mileage 4.5%.	3 LU	WSJ 8/25/77 p. 21
		First Version		$1.15/qt.		3 LU	WSJ 8/25/77
Mobil Oil Corp.	Mobil 1	Synthesized Motor Oil	Constructed molecule by molecule - 1976 - Reduces oil consumption, engine wear. Extends oil change intervals up to 15,000 miles or one year.	$3.95/qt.	Ave. increase in mileage 5%.	3 LU	WSJ 8/25/77 p. 21

FIGURE A-8. LUBRICANTS WORKSHEETS (Continued)

LUBRICANTS

WORKSHEET

CTP - MCI 12/2/77

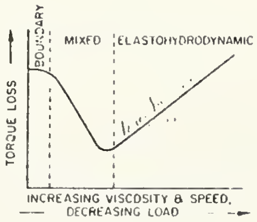
LUBRICANT MANUFACTURER	LUBRICANT NAME	LUBRICANT TYPE	NOTES	COST	GAS SAVINGS	MEDIA REF. BOOK NO.	REFERENCE
		Axle Lubricant	Complex relationships exist between torque loss, lubricant viscosity, vehicle speed, and load in terms of modes of lubrication in rear axle gear assembly. See Figure 1.  Fig. 1—Schematic diagram shows lubrication modes Optimum Lubricant characterisitcs: a relatively falt viscosity-temperature curve to maintain sufficient hi-temp viscosity while reducing losses at low temp. Viscosity selected to minimize torque loss for given speed and load. Auto rear axle is subject to a wide range of speeds, loads, and temps. Operation is usually at either side of the minimum torque loss.			3 LU	AE 11/77 p. 56
			Ford Motor Co., - Research estimates of fuel economy obtained by modifying lube viscosity-temp. behavior and frictional properties. Computer simulation was used. Insufficient data to determine fuel economy of 3% MoS_2 and 3% graphite lubes.		Small - for CVS and EPA highway cycles. 5% at low temp.		

FIGURE A-8. LUBRICANTS WORKSHEETS (Concluded)

MAGNESIUM Worksheet

CTP - MCI 12/28/77 MG page 1

Material	Tooling	Notes	Media Ref. Book	Reference
Magnesium		Expect increase in use of magnesium in auto production due to need to conserve energy and rapidly rising costs for aluminum. Current Mg-Al price ratio of 2:1 continues unchanged → only 1/4 lb./car to 1/2 lb./car in 1985. Mg-Al price ratio 1.5:1 → 20 lbs./car used in 1985.	3 MG	AMM/MN 6/6/77 p. 28
	die cast	Ford experimenting with use of die-cast Mg steering column lock cylinder housings, steering column activators, steering column flanges, master brake cylinders, distributors, vacuum advance diaphragm housings, and distributor rear cover diaphragm housings. Machinery does not exist to produce large components (such as transmission cases, oil pump bodies, wheels and clutch housings) by the economical hot-chamber die casting system, which would be needed for effective weight reduction. Also would need greater Mg production.		

FIGURE A-9. MAGNESIUM WORKSHEETS

PAINT Worksheet CTP - MCI 1/3/78 pages 1 & 2

Material	Notes	Auto Mfg.	Media Ref. Book	Reference
Enamels	GM trucklines switching from Alkyd enamels to acrylic enamels that are more resistant to corrosion.	GM	3 PA	WAW 9/77 p. 52
Primer	GM also using a rust resistant cathodic electrodeposition resin primer called Elpo on small sheet metal parts at GM Assembly Div. plant in Framingham, MA and wheels made at a Chevy plant in Warren, Michigan.			
	Decrease in number of colors from 1950's.			
Powders	Powders - can't take metalic finishes. Also, auto industry conversion to powder plant applications would require extensive and expensive changes.		3 PA	WAW 9/77 p. 52
Polyurethane Enamels	Polyurethane enamels Advantages: 1) deep, wet-looking finish and resistant to chemicals 2) high-solid content, which automakers like (more goes on car instead of into air) 3) baking temperature is at a low 150°F so energy consumption costs are modest Disadvantages: 1) inability to produce a metallic finish 2) potential hazard with resin 3) 2 parts: isocyanate - potential asthma problems in workers; acrylic or polyester			
Acrylic	Acrylic paints - acrylonitrite may be hazard to workers, industry does not think so → OSHA not yet ruled.			
	Volkswagen Mfg. Corp. of America finishes will be purchased from American suppliers franchised by Herberts Co. of West Germany.	VW		
Alkyd melamine Enamel	Alkyd melamine enamel finishes that contain very high solids → no water-base paints.			
	Ford Versailles 7 coats of paint in all--beginning with a seven-minute wash and phosphate shower and ending with 2 applications of clear acrylic.	Ford		
Non-Pigmented Enamel	Celanese - clear coat is a non-pigmented enamel that goes over a color base enamel, but the process can't be used on the acrylic lacquer finishes. The clear coat high on emissions of hydrocarbons. Cost factor important but may be only 15¢ or 20¢ per car if its spread across is exterior body finishes in a car line.			

FIGURE A-10. PAINT WORKSHEETS

PAINT	Worksheet	CTP-MCI	Media Ref.	1/3/78 PA page 3
Material	Notes	Auto Mfg.	Book	Reference
Chromated Pigments	Paints and finishes being examined for a number of reasons: 1) environmental considerations potential danger for worker handling them supersatured colors owe their vibrancy to chromated pigments made from hexavalent chromium.		3 PA	WAW 9/77 p. 52
Inorganic/ Organic Pigment	2) duplicating bright colors with organic pigments is possible but exceptionally expensive: one lb. dry inorganic pigment = \$1 - \$1.50 one lb. organics = \$12 - \$15 Shift to two-tone combinations--less saturated color. GM goal: 8% on 1978 models (up from 3% or 172,000 1977 cars)	GM		
Water-based Enamels	Ingredients in paint pigment for color resin for adhesion solvent for carrying mixture→but most give off hydrocarbons. Hydrocarbons are limited in L.A., so GM assembly plants there have switched to water-based enamels. (GM uses only lacquers on its cars; the other automakers use both enamels and lacquers on theirs.)			
	This GM solvent is 80% water so number of cars produced not limited but water-base process requires baking car bodies at 325°F and closely controlling humidity with air-conditioning equipment. Result: high energy costs.	GM		
	If increase energy consumption in factory→counter-productive step in view of national energy policy.			
Lacquer	Lacquer - can air-dry so its low energy user. Has to be rubbed and polished. GM bakes instead of rubbing--energy costs go up.	GM		
	Lacquer has low content of solids, while powdered pigments are 100% solid.			
Powders	Powders - lowest in solvent effluents and could save energy because workers are not in spray booth during applicator (outside air doesn't have to be heated for worker comfort).			

FIGURE A-10. PAINT WORKSHEETS (Concluded)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 1

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
Ford		Graphite/ epoxy strips		Reduces reinforcement wt. by a factor of 10. Yields 35% wt. reduction in finished frame rail. Load transfer stresses in adjacent, unreinforced rail need to be studied.	3PL	AE 85 No. 3 p. 40 (cont.)
				Anti-intrusion beams. Doors Metal beams absorb energy through plastic deformation. Also Federal Regulations were written with metals in mind.		
		Composites		Plastic deformation is alien to composites. Suggested for composite doors: Dual mode of energy absorption: Two graphite-epoxy belts, separated by structural-foam standoffs, mounted to door pillars by means of steel end plates. Standoffs make composite belts function in unison as a beam. With increased load, standoffs shear and belts behave independently as membranes carrying loads to the metal end-plates.		
	Barry Plastic Industries, Inc. (Minn.)	Poly-ethylene	Rotational Molding Technology	Company asked DOT why lightweight, high-density polyethylene material can be used for gas tanks in school buses but not in trucks. Material, produced by cross-linking molecules, has half the weight of steel and half the cost of aluminum	3GE	WAW 6/77 p. 46

FIGURE A-11. PLASTICS WORKSHEETS

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
			Injection Molding	Process is same as glass fiber process. Uses 1/24 in. chopped fibers. Has largest data base of any fabrication process amenable to auto production levels. Process is cost effective: Parts often used as molded. Dies can incorporate internal threads and the like. Cost of molding compounds is decreasing. Discontinuous fiber composites retain a substantial portion of the characteristics demonstrated by their continuous fiber counterparts. Role of process is making structural components is open.	3P L	AE 85 No. 3 p. 40 (cont.)
			Warm forming	A most potentially promising technique. Uses conventional stamping equipment to form composite parts from prepared sheets of graphite thermoplastics. Termperatures under 200°F could be used. Higher temperatures could be used with lower stamping pressures, e.g., 20 psi minimum pressure. Process is largely in development stage. Considerations: excellent deep-drawing capabilities limited capacity for stretch-forming some creep problems availability of graphite prepregs using PPS or nylone.		
Ford GM		Graphite/ epoxy		Committed to selective use of composite components.		
Ford			Filament wound	Driveshafts - Near term adoption. Tube is adhesively bonded to conventional steel yolks. Weigh 5 lbs. less than steel counterparts. Only heat shielded from exhaust system. Only rubber coated for protection from stone impingement. Exploit tortional strength and dampening, less balancing necessary. Springs Truck spring weighs 30 lbs. steel counterpart weighs 130 lbs. Auto leaf spring 4.5 lbs. steel counterpart weighs 28 lbs. Especially cost effective in truck applications - Reduce wt. and increases payload. Composite spring design has potential for modifying spring rates and loads within a given geometric envolope.		
		Graphite/ epoxy strips		Chassis Reinforcement in trucks via graphite epoxy strips is currently being studied. Method - prepreg strips are adhesively bonded to the rail and held in place by rotating rubber-backed steel guides. Required pressure for a heated cure cycle is generated by differential thermal expansion of the rubber.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 3

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
				Electrical characteristics affected by fiber type, loading, orientation, void content, and mosture absorption of the resin. 5) Friction and wear. Excellent lubricity. Lubricity depends on degree of graphitization of a carbon fiber suggested uses for chopped form of fibers: 1) molding, inexpensive, low-friction gears and bearings 2) brake linings, 3) rotors, and 4 pads.	3PL	AE 85 No. 3 p. 40 (cont.)
				6) Corrosion resistance is excellent. Jalvanic corrosion potential in instances such as a graphite thermoplastic mated with aluminum. Aluminum will corrode galvanically. Insulating fiberglass layer minimizes corrosion. Aramids somewhat sensitive to UV light, sufficient screening in complete composite minimizes loss of strength.		
				7) Impact resistance - relative values: Aramid composites > glass composites > carbon composites, 4340 steel. Lubridization balancing impact resistance, strength and cost.		
				8) Failure occurs through delamination and localized damage to the resin or resin/fiber interface. Little fiber damage occurs. Composite fabrication processes:		
			Compression Molding	Technique can use chopped-fiber SMC or pre-impregnated materials formed into unidirectional tapes, pre-plied sheets or woven fabrics. Molding cycle examples: 4 min. @ 2000 psi and 650-675^{0} F.		
			Filament Winding	Layers of fiber are laid upon a mandrel or as part of a sandwich construction. Liquid resin is applied simultaneously. Fibers can be built up at various orientations. Constrained by equipment geometry. Equipment costs are high. Process is time-consuming. Promising process for driveshafts and torsion bars.		
			Portrusion	Compares with extrusion process. Continous fibers are pulled through a resin bath and a heated die. Die simultaneously cures the composite and forms its desired cross section. Appropriate technique in fabricating laminated reinforcing strips. Primary advantage - fairly rapid speed in a continuous operation. Limitations - 1) constant cross section. 2) unidirectional fiber.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES WORKSHEET	MEDIA REF. BOOK NO.	REFERENCE
		Hybridized composites	Hybridization	Hybridization - mix of different fibers. Can increase flexural strength, impact strength and decrease cost of total hi performance fiber use.	3PL	AE 85 No. 3 p. 40
				Sandwich Construction Aerospace - composite skins over Al honeycomb Automotive - foam/composite designs and composite reinforcement of steel frame rails have been explored. Matrices		
		Thermosets		Thermoset - exoxies, phenolics, polyesters } require a cure cycle.		
		Thermoplastics		Thermoplastic - polysulfone polyphenylene sulfide (PPS) nylon		
				Mechanical Properties - depend on 1) type of fiber, 2) fiber loading, 3) fiber orientation, 4) resin matrix. Fiber orientation determines composite's response to applied stress, withstands stress along direction of fibers. Failure stress normal to fiber direction is approximately 10% of maximum strength of a given undirectional composite.		
				Characteristics to be considered in composite design 1) by varying fiber load and orientation a designer can locate maximum stress where he chooses. 2) potential for designing a composite with a controlled response to thermal gradients. Most fibers have slightly negative coefficient of thermal expansion along the fiber and a position one transversely. 3) creep resistance. Is a function of fiber orientation and matrix composition. Thermoplastics - relative creep resistance at 30% carbon loading. PPS > polysulfone and polyester > nylon and ETFE. Carbon reinforced material - total creep strain is approximately half that of a glass reinforced counterpart. 4) electrical conductivity is inferior to steels and aluminum alloys but superior to glass-fiber counterparts. Advantages and possible uses } substrate for electrostatic pointing radio frequency interference attenuation embossed static dissipation.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS WORKSHEET CTP - KO 11/16/77 PL p. 5

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
GM		Reinforced Composites		Corvette-all plastic seat	3PL	WAR 1/3/77 p. 5 (cont.)
GM		RIM		RIM molded facia - large scale production on Intermediates. All plastic door - still some years away from acceptance.		
GM		Fiberglass-reinforced plastic		1977 485 mill. lbs. used. 1976-1977 15% gain 1975-1977 49% increase. } Large percentage gains because there was very little plastics content in a car to begin with.	3PL	WAW 12/76 p. 84.
		30% fiberglass reinforced SMC		Heavy duty truck application - GMC General tilt hood and fender assembly weight 165 lbs.		
		High Performance Composites		High performance composites - composed of organic-based fibers incorporated into a matrix of some thermoset or thermoplastic material.	3PL	AE 85 No. 3 p. 40
		Carbon fibers		Carbon fibers: Amorphous - modulus values - 30 mill. psi. ultimate tensile strength - 450,000 psi. Graphitic - modulus values - 50 mill. psi. ultimate tensile strength - 400,000 psi. } density approximately 0.065 lb/cu. in. Production methods:		
	Hercules, Inc. licensee		Pan	1) oxidizing, carbonizing, and graphitizing a polyacrylonitrite precursor (most attractive method).		
			pitch-back integration	2) back integratiion of a pitch-based precursor, e.g. Thornel P fibers by Union Carbide.		
		Aramid		Aramid - aromatic polyamide materials modulus - 19 million psi. ultimate tensile strength - 430,000 psi. } density 0.053 lb/cu. in.		
		Boron		Boron - boron deposition on tungsten filaments too costly for automotive applications. Costs: carbon fibers current prices $20-$30/lb. aramid $8/lb. Long term costs - carbon fibers produced via PAN $6/lb. produced via pitch process - under $6/lb. Costs based on high volume production. Initial automotive applications will likely be seen @ fiber costs of $15-$20/lb.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 6

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
GM Assembly Div. St.Louis	GRTL Co. Birming-ham, Mi. Findlay, Ind. Inc. Findlay, Ohio Woodall Div. Detroit (LOF Plastics, Inc.)			Plastic seats - 1978 Corvette. Plans are now "tentative" and may be postponed. Certain executives think units are too costly to be justified.	3 PL	AMM/MN 1/31/77 p. 4
		Phenolic resin type plastic Fiberglass Reinforced polyester		New applications for plastics: transmission valve bodies; gears; wheels; doors; rear deck lids; ower steering reservoirs and pulleys. Growth areas: disc brake pistons; carburetor housings, transmission reactors; thrust washers. Growth areas: front header panels, wheel opening covers, spoilers, truck hoods, and fenders. Future applications - wheels, radiator supports, transmission supports, doors, hoods, rear deck lids, specialty vehicle bodies (reinforced thermoset plastic). Article lists materials currently used in above components. Plastics may cost 32-36¢ less than steel or aluminum, not indouding indirect benefits of weight reduction. Plastic gas tank - growth area: 1) tooling costs are 1/5 those of a steel tank. 2) resist rupture 3) can be made in almost any shape 4) don't rust.	3 PL	AMM/MN 1/3/77 p. 11
				Slowdown of dramatic new uses for plastics. Most likely changes will be increases in volume production. Big Three - trend is to produce more plastic parts in-house.	3PL	WAR 1/3/77 p. 4-5

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 7

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
GM			Molding	Chevrolet and Guide Division's are expanding molding facilities in Adrian, Michigan; Flint, Michigan; and Anderson, Indiana to handle substantial portions of Chevy and Pontiac programs. Chevy - Flint SMC parts.	3PL	WAW 1/77 p. 43
		SMC	Injection molding	Chevy - Adrian 350,000 sq. ft. for conventional injection molding.		
		RIM		Guide - Anderson RIM capacity expansion.		
GM	Guide Div. Davioson Uniroyal	Soft plastic		Soft plastic front and rear systems on '78 Intermediates.		
Chrysler				Purchasing a 160,000 sq. ft. plastic parts - making plant in Michigan City, Indiana from U.S.Steel Corp.		
Ford				Plymouth, Michigan Maumee, Ohio Sandusky, Ohio Saline, Michigan } Expanding plastic component mfg. capacity. Milan, Michigan - 765,000 sq. ft. plastics plant to be ready for production for 1979 model run. To be used for production of fender aprons, extensions, instrument panels, grille frames, gas tanks.		
GM				Annual outlay for materials and parts: $19 billion Plastics industry is valued at $16 billion. What auto mfg's. demand from plastics industry: 1) A way to attain better finishes on materials, e.g. a single low-temp paint curing process for both metals and plastics.	3PL	WAW 1/77 p. 40
		Graphite fibers		2) Bring graphite fibers down to $2.00/lb. The irons and steels currently used sell for 10¢ to 20¢/lb.		
GM Saginaw Steering Gear Div.		Nylon (glass reinforced)	Molded	Nylon injected molded steering column housing 1977 Chevy Vega. Replaces die cast portion above shift lever made from glass reinforced nylon resin. - Reduced production costs for raw material and secondary machine operations on the housings (formerly purchased outside). Weight reduction = 4 oz. Zn housing = 12 oz. } total weights. Nylon housing = 8 oz. Produces steering gears for 1) all GM models 2) at least some units for Ford, Chrysler, AMC. 3) units for other vehicle manufacturers.	3PL	WAW 1/77 p. 40

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 8

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
				New 1978 applications for plastic: 1) All plastic seats; 2) 2 different hi-volume applications for soft faced bumper systems. Types of Plastics - 1) RIM molded soft urethane 2) stampable glass - reinforced polypropylene 3) polyester sheet molding compounds 4) structural foam resins 5) other plastic materials.	3P L	WAW 1/77 p. 46
GM				Pioneer in large-scale applications for plastic. 8ucket seats - Corvette - either glass fiber reinforced polyester sheet molding compounds or hot stamped polypropylene.		
GM				Pontiac - soft face front and rear end systems including bumpers. RIM urethane skin combined with stamped, glassfiber reinforced polypropylene retainer and metal beam or backing bar. Most front end components integrated into urethane molding. '78 LeMans.		
GM				Chevy - Monte Carlo - soft face front and rear end systems. RIM flexible skins backed by polyethylene honeycomb energy absorbers and aluminum impact beams. Behind these bumpers GM is considering an SMC panel incorporating end caps, hood extension and grille frame. Will be a 2 or 3 part plastic concept.		
GM				Chevy Camaro - soft plastic nose. RIM urethane skins combined with structural foam molded plastic energy absorbing blocks, stamped polypropylene retainers and metal backing beams. Will be large enough to supplant the metal hood and fender extensions on the '77 models.		
GM		SMC	Compression molded	Chevy Caprice Classic '78 - SMC front end panels. Replaces assembly of steel, aluminum, polycarbonate, and mineral-filled nylon components.		
Ford and Chrysler				Have ordered equipment to expand plastic parts output in 1978 and beyond.		
Ford	Taylor Winfield Corp. Warren, Ohio	Thermoplastic	Proprietary thermoplastic stamping technique	8 hydraulic presses. Stamp out plastic fender liners at Maumee, Ohio plant via proprietary thermoplastic stamping technique developed last year. Will increase the number of models using these liners.	3PL'	WAW 1/77 cont. p. 46
				General listing of suppliers of materials and componenets for MY 1978 plastic applications.	3PL	WAW 1/77 p. 48

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 9

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
		Fiberglass		Belted radials - May be used more frequently because cost less than steel belted.	3PL	MT 4/77 p. 18
	Dupont	Fiber B		Aramid belted radials.		
	Goodyear	Flexten		Aramid belted radials.		
	PPG Ind. GRTL Subsidiary	PBT Thermoplastic resins		Richard Margolis - Mgr. Engineering & Tech. Service. Expect a 5-fold increase in PBT (polybutylene terephthalate) thermoplastic resins primarily due to auto applications. 26 million lbs. - 1977 130 million lbs. - 1981	3PL	WAW 3/77 70
	Exxon	All types plastic		E.F.H. Pennekamp, Dir. of Automotive Development MY 1977 - average 180-185 lbs./car, i.e. 4-5% of average curb weight. MY 1985 - predict approximately 350 lbs./car.	3PL	WAW 3/77 p. 70
		Olefins		Base material for most plastics. Produced in Baytown, Texas plant.		
		Polypropylene		Battery cases weight - 1.6-2.0 lbs. Save 4-5 lbs. over hard rubber.		
Ford		Graphite fibers		Engineer. $5-10/lb. price needed for production. This price is coming.	3PL	WAR 3/7/77 p. 76
Ford		Graphite fiber composites		Possible applications - push rods, wrist pins or connecting rods, bumpers, driveshaft yokes, hoods, deck lids, transmission supports, frame cross members and door beams, springs, driveshafts. Could replace existing plastic and aluminum alloys which are not light enough. Julius J. Hardwood, Dir. Materials Science Laboratory Interview:	3PL	AMM/MN 2/21/77 p. 5
		Graphite FRP		tapered leaf spring - 4½ lbs. Conventional steel spring = 28 lbs./spring. truck leaf spring = 30 lbs. Conventional steel spring = 130 lbs./spring. alteration of design could provide further weight reduction. NASA willing to work with auto industry on developing applications for graphite composites. Hope for improvements in material costs.		
		Carbon fibers		$2.50-5.00/lb. needed for high-volume car components. Possible weight reduction HSS:10-30% AL:40-50% Plastics;50% Advanced composites 70+% e.g. carbon-fiber reinforced Epoxy.		
		Advanced Composites		Can be fabricated by same processes used for glass fiber composites.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

WORKSHEET

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
GM				Monte Carlo MY 1978 plastic front end panels weigh 12 lbs. less than 1977 assemblies. All al. deck lid Al. rear brake drums Al. reinforcement bars Soft plastic bumper, front and rear Malibu and Malibu Classic - front end panels save 7 lbs. over metal assemblies.	3PL	AMM/MN 7/25/77 p. 1
	Kostal	Delrin		Leading electrical component manufacturer - Steering column switch assembly. Has 1. close tolerances 2. dimensional stability 3. smooth finish - avoid the need for lubrication 4. no post machining necessary Made of "delrin" = acetal homopolymer resin.	3PL	AMM/MN 7/25/77 p. 1
	Owens-Corning			A modest increase in insulation material/car could result in 30-40 lbs. weight savings (e.g. a smaller generator) due to increased thermal efficiency.	3PL	WAW 6/77 p. 46
		Powder/metal (p/m)		Powder/metal (P/M) components. Ave. U.S. Built car - 10-15 lbs. p/m: transmission, ignition, bearing and shock absorber parts. Advantages of p/m: wt. savings elimination of machining operations	3PL	AMM/MN 6/6/77 p. 26
	Delco-Remy			p/m cranking (ignition) motor program - smaller size; lighter wt; longer life; reduced costs. Quality of p/m materials is good. Now need to improve quantity (cost.)		
	Budd Co.	Foam-filled fiberglass reinforced polyester		Structures are efficient energy absorbers for front ends.	3PL	AN 6/6/77 p. 11

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/78 PL p. 11

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
	Owens-Corning Fiberglass Corp. R&D Ctr. Granville, Ohio	Reinforced Plastic		Currently working on: wheels, doors, leaf springs, "friendly fender". Leaf springs - at least 5 years away - combination of Kevlar, fiberglass and graphite.	3PL	WAR 8/1/77 p. 243
GM				Sliding doors for vans & GM/s 1980 MY wagon van.		
GM Chevrolet Buick	Chevrolet plant Adrian, Michigan			Plastic inner fenders (fender liners) on Malibu, Malibu Classic and Monte Carlo Buick Century Regal --- will weigh 7 lbs. each and save at least 10 lbs./car.	3PL	AMM/MN 8/1/77 p. 5
Pontiac	Termofil, Inc.			Will use conventional steel fender liners on MY 1978 Intermediates.		
Olds	Dart Ind. Fiberfil Div. Hercules Inc. Owens-Corning			MY 1978 Intermediate fender liner material not yet known.		
Ford	Maumee Ohio plant	Stamped thermo-plastic	Thermo-plastic stamping	Increase use of plastic fender liners in MY 1978. Fender liners for new "F" series light duty trucks Ford converted metal stamping equipment to plastic forming applications.		
GM Chevrolet Flint, Michigan	Sherwin-Williams Co., Cleveland Ohio (coating) General Tire & Rubber Co.	glass fiber reinforced (compression molded) polyester		Full length front header panels - contain hood extension, grille surrounds, and fender extensions. Pioneering breakthrough use of primers for plastic body parts, covers up imperfections in panel surfaces. Considering several continuously-developing coatings. Polyurethane primer - to be used on MY 1978 Malibu, Malibu Classic and Monte Carlo front header panels. Working on primers that can be applied while still in the forming machine molds.	3PL	AMM/MN 7/25/77 p. 1

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

WORKSHEET

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
				350-500 lbs. plastic in MY 1985 cars. Improvements in plastic technology needed: 1. quality 2. fade resistance 3. texture 4. finish 5. uniformity of fiber content Graphite fiber reinforcement - possible today at hi-cost and low volume only.	3PL	WAR 8/22/77 p.
	Owens-Corning	Fiberglass	Filament Wound	Passenger car springs. weight 7-9 lbs. rather than 30 lbs./spring for steel. 70% glass by weight: filament wound	3PL	AN 8/15/77 p. 16
		Kelvar or Graphite fiber	Poltrude	Could also be used. Could poltrude spring.		
GM Chevrolet	Working with General Tire & Rubber Company	In-Mold Primers	Compression Molded	Oavid McLellan, Chief Engineer, Corvette. Will use in-mold primers, or coatings, on compression molded plastic body parts. 1st use: to coat roofs of 1979 Corvettes. Process eliminates: 1. post mold priming time 2. some finishing expenses associated with SMC parts. Process permits: 1. Design of thinner plastic panels with built in strengthening sections.	3PL	AMM/MN 8/15/77 p. 5
GM Chevrolet		Fiberglass Reinforced Hi-strength Plastic		Molded plastic radiator supports to replace stamped steel units. Possibility of production before end of MY 1978.	3PL	AMM/MN 8/15/77 p. 5
Ford				Instrument panels - industry wide - are either stamped steel or compression molded plastic SMC.	3PL	AMM/MN 8/8/77 p. 14
		Structural foam molding		New process suitable to production of large parts, e.g. 7½ ft. CL9000 heavy-duty truck instrument panel made of 11 molded parts. Weighs 5 lbs. less than steel and somewhat less than SMC. Will have structural ribs molded into panels. General Applications: Limited use in glove box doors and fan shrouds for autos. Jeep vehicles MY 1976 - removable top (debut application of compound) Equipment categorized as high or low pressure, referring to the internal cavity pressure of the molds.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS WORKSHEET CTP - KO 11/16/78 PL p. 13

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
Volkswagen AG, West Germany		RIM Poly-urethane		Bumper system - replaces steel bumpers with hydraulic shock absorbers on MY 78 Dasher. Changed systems due to: 1. reduction in cost of plastic raw materials. 2. advancement of RIM techniques. 3. considerations of weight and dent resistance. New bumpers: weigh 15% less than former metallic ones. Shaped in U profiles. Reinforced by integral vertical ribs in center section, and vertical, horizontal, and diagonal ribs at corners. Foam portion attached to steel supporting beams welded to car body. Input kinetic energy transferrred to steel supporting beam and car body. No permanent deformation at low speed.	3PL	AMM/MN 10/3/77 p. 16
	Society of the Plastics Industry	Reinforced Plastic		In MY 1977 cars: 200 exterior parts 100 interior parts 125 functional components At least 34 models have fiberglass reinforced plastic front ends.	3PL	AMM/MN 9/19/77 p. 9
		Composites		Navy F-18 - cost of composite parts is approx. equal with competing metal components. Current cost of composite material $42/lb.	3PL	AMM/MN 9/12/77 p.19
	Northrop	Composites		Major drop in costs due to manufacturing improvements e.g. total co-curing of inner and outer panels together; transfer of patterns from cutting table to tool by robots using vacuum heads - in a few years.	3PL	AMM/MN 9/12/77 p. 19
	Northrop	Advanced Graphite Epoxy Composites		Aircraft Div., Hawthorne, Ca. - early Oct. plant "opening". Fabricate composites on production scale based on use of a computer-controlled reciprocating knife and computer-aided design. A generic facility for all Aircraft designs Aiming at 90% material utilization rate.	3PL	AMM/MN 9/12/77 p. 18
Ford				Fairmont/Zephyr MY 1978 147 lbs. plastic (up from 105 lbs. in Comet) 1985 average car 3,000 lbs. 1977 average car 4,200 lbs. 1978 average car 4,000 lbs.	3PL	WAR 9/5/77 p. 285
GM				Chevrolet Monte Carlo's Guide Flex MY '78 bumpers are approx. 100 lbs. lighter than MY 1977 Monte Carlo's bumpers. Painted plastic outer skin and bright metal trim.	3PL	AN 8/29/77 p. 3

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
		ABS		Exterior body parts - needs urethane paint system which cures at a temperature less than 200°F.	3PL	AN 10/10/77 p. 20
	Borg-Warner	ABS		Structural seat shells - acceptable design would be a composite of metal and solid thermoplastics rather than foam or glass-filled foam.		
International Harvester Truck Group		Molded Composite		Using fibers like glass, boron, graphite in a liquid resin. Advantages: Increased pay load Rust proof Indefinite life Tool a cab for approx. 1/5 the cost of today's metal cab 35% of engineering time is spent assuring compliance with current safety standards. Retro devices for reducing friction, wired resistance, and HP requirements as well as smooth sides can reduce fuel consumption by 14.9%.	3PL	AN 10/3/77 p. 8
	Union Carbide Corp.	Thornel Carbon Fibers		$20/lb. Product Mgr.:, N.Y. headquarters - Dale C. Hiler	3PL	WAW 10/77 p. 94
		Carbon Fiber Composites		Tested in drive shafts, leaf springs, push rods, side door intrusion beams, brake pads, etc.		
	PPG Industries Inc.	New HMC and XMC Compounds		John M. Ford: Applications research on the use of high-modulus carbon fiber with fiberglass. To increase the rigidity of HMC and XMC hi-strength compounds. Potential production: Volume: 50 million lbs. annually by 1981.		
	Owens-Corning	SMC		Versatile tooling - can crank out SMC with a wide variety of glass loadings, including directional fibers (as in SMC-D) and continous fibers (as in SMC-C). Highest tests are at 65% loading. Impact and flexural properties increase with increasing glass content: Conventional 30% SMC - unnotched izod impact strength 18-21 ft.-lb./in. 65% glass SMC - 35-42 ft.-lb/in.	3PL	Owens-Corning Fiberglass Advertisement
		Hybrid Composites		"high modulus" reinforcements added to glass fiber composites Applications tested: doors, wheels, radiator supports, transmission supports, sprints.		

FIGURE A-11. PLASTICS WORKSHEETS (Continued)

PLASTICS

WORKSHEET

CTP - KD 11/16/77

PL p. 15

AUTO MFG.	SUPPLIER	MATERIAL	PROCESS	NOTES	MEDIA REF. BOOK NO.	REFERENCE
Ford		Graphite		Graphite Program Phase I - installed graphite parts, e.g. door and hood on an experimental Granada. Phase II- build prototype car weighing approx. 2750 lbs. 1250 lbs. weight savings. Issues to be resolved for mass production: 1. cost. 2. damage resistance. 3. recycling process. 4. easy applicability to auto manufacturing. Expect graphite to show up in cars of the 1980's.	3PL	WSJ 10/22/77 p. 2
GM Guide Div. Anderson, Indiana		Soft Plastic	Chrome-Sputtering	A method for chrome plating soft plastic bumpers. If successful, would increase the use of soft bumpers. Used in MY 1977 to chrome coat rigid plastic lower grilles on Chevrolet Caprice.	3PL	AMM/MN 10/24/77 p. 22
Chevrolet Motor Flint, Michigan		Rigid Plastic		Scheduled May'78 to coat ABS plastic grilles for 1979 Chevette line. Considering chrome-coating flexible lower grilles on future Camaro cars.		
	Borg-Warner Corp. Automotive Polymers	ABS Plastic		1977 average is 15.2 lbs./vehicle (including trucks) ranges 27 lbs. for large cars to 13.9 lbs. small cars scheduled for redesign by MY 1979. Chief applications - instrument panels, interior trim, grilles and bezels.	3PL	AN 10/10/77 p. 20
AMC	Borg-Warner Corp.	Cycolac 2-48		A high-heat ABS. Developed for unpadded instrument panels that extend to the windshield and require more heat resistant material. Used on the Concord.		
		ABS		Advantages: 1. offers close tolerance and low temperature impact resistance which is needed for large or complex parts. 2. is easily decorated. Potential uses: 1. large grille surrounds. 2. chromed mirror housings. 3. door handle assemblies 4. structural seat shells. 5. exterior body components.		

FIGURE A-11. PLASTICS WORKSHEETS (Concluded)

SCRAP

Worksheet

CTP - MCI 12/28/77 SC p. 1

Material	Tooling	Notes	Media Ref. Book	Reference
Scrap		Dealers and processors told that more sophisticated manangement plans are needed in a scrap age of risk, technology and high variable costs (vs. current seat-of-the-pants decisions).	3 SC	AMM/MWN 11/7/77 p. 35
Scrap (Ferrous)		Traders and consumers anxious about drop in price in ferrous scrap market and availability. Traders will sell only the tonnage acquired at a price they can make a profit on, and will hold back all higher-priced inventory. Scrap with zinc contamination can be as much as $10/ton lower than regular bundles. Certain grades of material, which react to the price of factory bundles are "artifically depressed" due to an inadequate distinction being made between prices for regular bundles and for zinc-laden ones. Steel imports have cut production at domestic mills so less ferrous scrap is being demanded.	3 SC	AMM/MWN 11/7/77 p. 35
Scrap (Ferrous)		Big 3 Auto Makers expected to generate 1.05 million gross tons of regularly-advertised stamping scrap in 1977, based on an average 84,411 tons generated per month so far this year. Would be within 8.6% of 1.15 million tons generated in peak year of 1973, despite car designs using less steel. Prices per ton dropped monthly in 1977 from average $75.38 to $58.30.	3 SC	AMM/MWN 9/5/77 p. 33

FIGURE A-12. SCRAP WORKSHEETS

STEEL Worksheet CTP - MCI 1/13/78 ST p. 1

Material	Process	Notes	Supplier	Cost	Media Ref. Book	Ref.
	P/M hot pressing	(2) Handling the hot preform. Mechanical, electro-mechanical and pneumatic feeders developed to meet criteria of minimal overall heat loss, minimum exposure to air, minimum surface contact in order to avoid formation cold spots in the parts, and with proper orientation at the pressing station.			3 GE	AE 7/77 p. 30
		(3) Lubrication. Graphite most suitable.				
		(4) Tool Materials. Much higher than usual tolerances, more intricate configuration, minimal acceptable tool wear required. Most commonly used tool material is H-13 hot work steel, though M-2 and M-4 high speed steels and H-21 used in some applications.				
		(5) Tolerances. Tighter tolerances, higher cost				
		(6) Preform Design - Most important factor in producing a good hot pressed P/M part. Properly design preform will provide enough material flow to produce the desired mechanical properties and uniform density, but not enough to cause fractures, erode tools quickly or require excessive forming pressures.				
		Cleaner powder,with a much lower oxygen content, was needed for hot pressings than for normal P/M production. Current or possible auto applications overrunning clutch rolls, connecting rods, differential gears, brake parts.			3 GE	AE 7/77 p. 30
		Many surfaces which require machining when produced by conventional methods are suitable for use directly from the P/M hot pressing operation.				

FIGURE A-13. STEEL WORKSHEETS

STEEL <u>Worksheet</u>

CTP - MCI 1/13/78 ST p. 2

Material	Process	Notes	Supplier	Cost	Media Ref. Book	Ref.
Steel Powder	P/M hot pressing	P/M hot pressing process used in making complex parts, can reduce finish-machining costs. Basic steps in hot pressing: (1) Cold compacting (2) Preheating (or sintering) (3) Hot pressing operation (implying near-theoretical density) in a completely closed die set, usually at a temperature lower than that for conventional forging. (a) repressing--basically a "no flow" sort of operation by which a part has its porosity "squeezed out" and decreases its dimensions, or (b) upsetting--which involves flow of the metal and some change in shape as well as size for a given volume. This generally provides more directional properties, better strength, and improved fatigue and impact properties.			3 GE	AE 7/77 p. 30
		Not as simple a process as originally "advertised", significant learning curve for producer to provide components having good quality and economic attractiveness.				
		Early problems and reasonable solutions: (1) <u>Heating the preform</u> The controlled atmosphere induction furnace became the most common method of heating preforms--rapid heat rate, compact size, placed close to press so reduced transfer distance, able to prevent decarburization and scaling in steels (which make up virtually all of the present production of this process as well as roughly 80% of conventional P/M parts). Also permits cold parts to be fed in one end with hot one being ejected at the other.			3 GE	AE 7/77 p. 30

FIGURE A-13. STEEL WORKSHEETS (Continued)

STEEL WORKSHEET CTP - MCI 1/13/78 ST p. 3

Material	Process	Notes	Supplier	Media Ref. Book	Reference
High-Strength Steel (55-60,000 psi)	Chrome-plated	<u>1978 Uses</u>: (1) <u>Bumpers</u>: Chrysler Volare and Aspen bumper systems 24 lb. lighter than 1977 mild steel systems. Pontiac Sunbird AMC Pacer bumpers save 30 lbs./vehicle Chrysler Diplomat and LeBaron bumper face bars at rear save 7 lbs./car. Chrysler Plymouth Fury and Dodge Monaco bumper face bars in front save 23 lbs./car. GM intermediates -- front and rear bumper face bars.	Bumpers--Houdaille, Industries Steel-Great Lakes Div. of Nat'l. Steel Corp. Republic Steel Corp. US Steel	3 GE	WAW 9/77 p. 44
70,000 psi Steel		(2) <u>Door Beams</u>: Ford Fairmont, Zephyr	Youngstown Sheet and Tube Co.		
80,000 psi 60,000 psi	hot-rolled cold-rolled	GM Intermediate			
		(3) Rear suspension arms and brackets on Fairmont and Zephyr and front shock absorber mountings			
		Experimental bumper built for 1976 Chevy Monza 2 + 2 that has potential, with minor modifications, to meet safety standards in 1980 as well as weight reduction. Bumper plus hardware = 31 lbs. compared to 41 lbs. for mostly plastic assembly on current Monza model.	US Steel	3 GE	WAW 3/77 p. 52

FIGURE A-13. STEEL WORKSHEETS (Continued)

WORKSHEET

Material	Process	Notes	Supplier	Media Ref. Book	Reference
		Steel companies and unions agree that steel imports pose peril to US Steel Industry. US major producers trying to cut costs, trim capital spending, tailor their operations and facilities to actual demand. Even with some plant shutdowns or bankruptcy (Alan Wood Steel Corp.), supply potential far greater than demand.		3 St	AMM/MN 8/29/77 p. 22 AN 7/25/77 p. 8
Zincgrip	Cold-rolled steel sheet with a hot-dip zinc coating on one side.	Aimed at automotive applications. Similar to conventional galvanized steel sheet but no masking agent used. Coated side free from coating irregularities. Uncoated surface free of contaminants and marks. Costs slightly higher.	Armco Steel Co.	3 St	AN 7/25/77 p. 8
Chrome-plated carbon Steel	FRED. First-rate electro-deposition	Two-year study in progress on corrosion-resistant steel FRED process deposits chromium on surface layer only, rather than by conventional bulk alloying. Process followed by controlled thermal diffusion of chromium electroplates into the steel using high-frequency induction heating. Expected savings in chromium and energy because efficiency of FRED is about 40-50% compared with 12-15% for conventional process. Potentional reduction in production costs 30-60%. FRED process can deposit chromium at a rate of 0.6-0.7 mill per minute (60X conventional rate) 2 stages research: (1) study FRED process; (2) investigate co-deposition of molybdenum with chromium to improve corrosion-resistant properties.	Batelle Labs (Columbus Ohio)	3 St	AMM/MN 9/5/77 p. 30

FIGURE A-13. STEEL WORKSHEETS (Continued)

STEEL

WORKSHEET

CTP - MCI 1/13/78

Material	Process	Notes	Supplier	Media Ref. Book	Reference
		Impact-crushing of high-strength steel--SAE report. Conclusions: For the test conditions (up to 40 mph and down to -40^{o}F) and materials investigated: (1) energy absorption of steel increases with impact velocity and at the lower temp; (2) Tube geometry significantly influences the amount of energy absorbed with a square tube absorbing a third less energy than a circular one having an equal volume of material; (3) Most important, high-strength steels absorb energy in proportion to their strength level, the significance being that they may be used in relatively light gages to reduce vehicle weight.		3 St	AE 3/77 p. 58
		Shortage of iron and steel scrap shaping up in spite of rising prices of the material. Solid, reliable supply of scrap is essential to sustaining operations of the steel and iron industries. Five major reasons for shortage in scrap, according to survey made by Iron and Steel Institute: (1) Growth in electric furnace steelmaking; technology based on scrap; (2) Improvements in methods of making steel and castings are boosting production yields and cutting supply of scrap generated on-plant; (3) End users of steel improving their efficiency and cutting the availability of industrial scrap usually sold to processors; (4) obsolete scrap will be in higher demand but harder to prepare for recycling and less reliable in terms of its physical and chemical characteristics; (5) Supply of obsolete scrap will not expand enough to meet future demand: Domestic: 1982: 66.3 million tons purchase scrap demand 1973: 48.6 million Export demand: 1982: 15.3 million, increase 35% over 1973. Total demand 81.6 million tons in 1982 (est.) Total supply 70.7 million tons in 1982 (est.)		3 St	AN 7/25/77 p. 8

FIGURE A-13. STEEL WORKSHEETS (Continued)

STEEL CTP - MCI 1/13/78 ST p. 6

WORKSHEET

Material	Process	Notes	Supplier	Media Ref. Book	Reference
		<u>Survey of steel companies</u>: Steel content of average car could drop by 700-800 lbs. by 1983. Expect total tonnage to car and truck industry by 1985 to remain about same as 1977 MY (22.1 million ton) but expect more to trucks and less to cars. <u>Differences in opinion</u>: 1) Weight of cars in 1985: 3050 lbs. to 2800 lbs. compared to 3859 for '77 MY 2) Steel content estimate: 65% (today) to 55% in 1985.		3 St	6/6/77 WAR p.,181
		Pres. McCord Corp looking at replacements for components made of steel; fast foam materials made by RIM process good candidates. Experimental inner door panel saves 25 lb. in each sedan door.		3 St	4/18/77 WAR p. 122
		Problems in worldwide market: Companies with EEC restrain sales within market so push US sales until June 30. US companies complain that EEC held back in 1976 and are looking for trade curbs.		3 St	WAR 3/21/77 p. 93
High-Strength Steel		Unveiled new high-strength steel aimed at use in doors, hoods, rails and body pillars. Dubbed "ding-no-mo" said to be 50% stronger and allow 20% gauge reduction in body panels.	Chrysler	3 St	WAR 3/7/77 p. 76
		Steel outlook better for 1977. Chairman of US Steel believes total 1976 shipments 91 billion tons and 1977 estimate 100 million tons. Possible cash flow problems. Galvanized steel floor pan, outer wheel house in GM downsized '77 cars.		3 St	WAR 1/3/77 p. 4

FIGURE A-13. STEEL WORKSHEETS (Continued)

STEEL		WORKSHEET	CTP - MCI		ST p. 7
Material	Process	Notes	Supplier	Media Ref. Book	Reference
HSLA Steel		HSLA Steel bumper--0.052 inches thick; each bumper system 1% of gross vehicle weight. "Limited access" design, using strategically placed bumper guards to redirect impacts to minimize denting.	US Steel	3 St	AI 8/1/77 Adv.
	One-piece molded seal and reinforcement	"Steel belted" high pressure shaft-to-bore seal: solve potential problem of seal failure in low speed reciprocating and oscillatory devices. Conventional seals are displaced and often blown out of place when high pressure fluid distorts the elastomer sealing member. "High pressure breathing" is another problem as the seal flexes and relaxes under pulsating fluid pressure. 2 parts: (1) metallic cylindrical cup extends parallel to sealing surfaces of elastomer body and helps provide leakproof engagement of the seal with the bore; (2) flat washer member locates the seal in the bore and provides support to resist pressure exerted on the seal by the fluid medium.	Int'l. Packing Corp.	3 St	AI 8/1/77 p. 75
High Strength Galvanized Steel	Cold-rolled	Ford Fairmont and Zephyr will have high strength steel fuel tank reinforcements and upper mounting brackets for rear springs for safety reasons. Steel will be 50-80,000 lb./sq-in range. Door intrusion beams will be 70,000 lbs./sq.-in. titanium-bearing cold rolled steel.	Youngstown Steel Corp.	3 St	AMM/MN 7/25/77 p. 12

FIGURE A-13. STEEL WORKSHEETS (Continued)

Material	Process	Notes	Supplier	Media Ref. Book	Reference
		Steel company cutbacks and sagging profits have prompted mayors of 16 steel-making cities to ask for federal assistance to help combat industry problems, which include increasing foreign competition; converting old plants to meet new pollution requirements and the difficulty of generating capital for modernization. In similar situation in 1954, GM supplied funds to four of its steel producers in the form of loans, for which GM was reimbursed against the tonage of steel delivered. But today there is a reduced demand for the structural shapes normally tied to capital expenditures.		3 St	WAR 9/12/77 p. 291
HSLA Steel		Ford Fairmont (1978) = 138 lb. Ford Maverick-Comet (1977) = 75 lb.		3 St	WAR 9/5/77 p. 285
HSLA Steel	Cold-rolled. Retain current machinery	Steelmakers expect expanded use of HSLA steel in 1980's. New cold-rolled HSLAs down to .02-in with 45,000-60,000 lb. minimum yield strength will become generally available in the near future for use in body panels, hoods, doors, structural components, car floors: styling flexibility.		3 St	WAR 8/29/77 p. 274
	Hot-rolled	Expanded use HSLA hot-rolled steels with 80,000-100,000 lb. minimum yield strength for car frames, suspensions, etc. Expanding use to meet safety and weight requirements.			
USS Galva-One	CAROSEL (consumable-anode radial one-sided electro-plating)	New sheet metal developed for use on auto exterior body panels. Interior is coated to prevent corrosion and outside is bare for paint. Zinc coating done before fabrication so interior completely protected. 900 foot line with 18 plating cells. 700 feet per minute coated. Sheet thickness 0.023-in. through 0.050-in. and widths from 36 to 64 inches. Standard coating thickness applied is 13.7 micrometers minimum, which is equivalent to 0.32 ounces of zinc per square foot of surface.	US Steel	3 St	AN 8/29/77 p. 31

FIGURE A-13. STEEL WORKSHEETS (Continued)

STEEL Worksheet CTP - MCI Media Ref. 1/13/78 ST p. 9

Material	Process	Notes	Supplier	Book	Reference
Steel	Stamped	Ford has production scheduled in Cleveland plant in 1979 or 1980 for stamped steel rocker arms. Auto makers also studying ceramics and high-performance carbon-fiber reinforced plastic stamped steel lighter weight than cast steel. Steel is less costly than carbon fiber units.		3 St	WEU 9/16/77 p. 3
		Characteristics in steel desired by Japanese auto industry (enumerated by Toyota spokesman): (1) high-tensile-strength steel with good workability to help cut auto weight while increasing safety in crashes. (2) rustproof steel with improved welding capabilities that is also easy to paint (3) high dampening to absorb vibration and noise (4) stable prices		3 St	AMM/MN 10/24/77 p. 5
		Government and the Steel Industry Traditional adversary relationship should be re-examined. Better planning needed by government and industry together to help industry and economy. Government actions are often contradictory or done with little regard for the efficiency or long-term health of industry: "Passing the buck" between Labor Department, Commerce Department, Justice Department (anti-trust); IRS, Treasury Department is common and counterproductive. But steel industry should "abandon its view of gov't as adversary and encourage the gov't to take a more coordinated and planned response to its problems," according to Paul Marshall, consultant to American Iron and Steel Institute.		3 St	WSJ 9/26/77 p. 8

FIGURE A-13. STEEL WORKSHEETS (Concluded)

ZINC Worksheet CTP - MCI 12/29/77 ZN page 1

Material	Process	Notes	Supplier	Auto Mfg. Model	Media Ref. Book	Reference
		1978 Models--increased use of special coatings and coated products though not as big an increase as in 1977.		GM Intermediates	3 GE	WAW 9/77 p. 46
	Hot-dip galvanized steel electro-galvanized steel	Galvanized steel makes biggest gain in 1978. GM intermediates make intensive use of one-side and two-side galvanized on applications that previously had depended on other coatings or none at all.				
		Galvanized outer door panels, outer quarter panels, some spare tire pocket and rocket panels.		GM Olds Cutlass		
	zincrometal	Zincrometal and spray-on zinc primers applied to floorpans.				
		Increasing use of pre-coatings, or corrosion-resistant coatings that are applied to sheet metal prior to the fabrication of components.			3 GE	WAW 3/77 p. 53
	Zincrometal	Ford				
	Galvanized Steel	Chrysler				
		Major areas on cars--deck lids, rear outer wheelhouses, rear quarter panels, outer door panels.				

FIGURE A-14. ZINC WORKSHEETS

Material	Process	Notes	Supplier	Auto Mfg.	Model	Media Ref. Book	Reference
Zinc		Caterpillar Tractor Co. cutting the use of zinc which the company considers scarce materials.				3 ZN	AMM/MN 11/14/77 p. 5
Zinc		Ford and auto industry increasing use of zinc in spray coatings, galvanized steel and zincrometal as protection against corrosion is improved.		Ford	'78 Thunderbird	3 ZN	AMM/MN 8/29/77 p. 5
Zinc	die cast	Claims energy requirements of engineering materials by weight is lower for zinc than plastics (including energy equivalents of feedstocks and all energy used from raw material up to point of fabrication). Cost zinc .41/lb., cost plastic is $1.02/lb.				3 ZN	WAW 6/77 Advertisement
	Zincrometal	V.P. materials purchasing for Ford suggested usage of zincrometal and zinc-rich coatings by the automotive industry for corrosion resistance purposes has probably peaked. Little else to be protected on car. For each 100 lbs. of weight reduction, average motorist would save merely $10/yr. in gas. Recent claims of significant improvement in cathodic electrodeposition of paints may suggest some decrease in auto use of zinc-rich materials.	Diamond Shamrock Corp. developed & patented process.			3 ZN	AMM/MN 6/20/77 p. 25

FIGURE A-14. ZINC WORKSHEETS (Continued)

ZINC Worksheet

CTP - MCI 12/28/77 ZN page 3

Material	Process	Notes	Supplier	Auto Mfg.	Model	Media Ref. Book	Reference
Zinc		Under consideration: Fender extensions for front ends of some cars, thin wall opera window moldings, headlamp housings and corner lamp housings.		GM	Chevrolet	3 ZN	AMM/MNN 1/24/77 p. 17
		B.F. Gray, Superintendent of process engineering, estimates Guide will save 425,722 lbs. of zinc with 15 castings during 1977 MY due to switch to thin wall construction.	GM Guide Div.	GM			
Zinc	die cast	Increase in use of thin wall zinc die castings but often replacing thicker zinc die castings rather than components employing other materials so total amount zinc used is still declining. 60-80 new applications for zinc die castings on 1977 model cars & trucks.			1978 Models (planned)	3 ZN	AMM/MNN 1/24/77 p. 17
		Grille frame		Chrysler	Cordoba		
		Door handles and coat hooks		GM			
		Grille frame-switch from thick to thin zinc wall		Ford	Mark V		

FIGURE A-14. ZINC WORKSHEETS (Concluded)

APPENDIX B. COMPONENT WORKSHEETS

BRAKES

WORKSHEET

CTP - MCI 11/15/77

BR page 1

SUPPLIER	AUTO MFG.	MODEL	NOTES	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
	GM	'78 Buick, Olds, Pontiac	Aluminum rear brake drums. Last seen on '70 Buicks. Weight reduction and improved ride due to reduced unsprung weight.	Aluminum			Lower Weight	4 BR	WAR 8/29/77 p. 275
Bendix	Chrysler	Valiant Galant Nov. 1977	Light weight disc brakes for small cars. Series IV design eliminates anchor plate and replaces it with two sleeves which are sealed and lubricated, reducing the unit's weight and providing a sliding surface protected from contamination. Reduces drag of disc brake significantly.					4 BR	AE 5/77 p. 44
			Design: 2 piece composite modular construction using an aluminum cylinder housing and nodular iron bridge.	Nodular iron bridge					
			2.5 inch diameter caliper intended for 101-111 in. wheel base, 2500-3600 lb. curb wt. (3600-5000 lb. gvw).	Aluminum Alloy 3331 caliper body			2.5 in. dia. caliper. 12.6 lb.=iron. 7.5 lb.=series IV aluminum.		
			1.875 - 2.125 diameter caliper intended for 93-100 in. wheel base, 1900-2300 lb. curb wt. (2600-3400 lb. gvw).				1.875-2.125 in. caliper. 6-3/4 - 9-3/4 lb. = iron. 4.5 lb. = series IV aluminum.		
			Primary alloy characteristics: strength, rigidity, pressure tightness. Secondary alloy characteristics: castability, machinability, wear, corrosion resistance.						

FIGURE B-1. BRAKES WORKSHEETS

BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Houdaille Industries	Chrysler	1979 downsized standard models - R body. 1st use of chrome-plated alum. bumpers. Cost and technical difficulties until now have prevented chrome-plated alum. bumpers from entering production use in. U. S.	Fabricated plating pre-plating	Chrome-Plated alum. bumpers	Lighter than steel			4 BU	WAW 10/77 p. 87
		'78 Plymouth Horizon. 1st all aluminum bumper for Chrysler.		Aluminum					
		'78 Dodge Omni.							
Reynolds	GM	Sheet bumper reinforcements and brackets. '78 "B" body Chevrolet, Olds, Cadillac, Buick, Pontiac.		Aluminum				4 BU	WAW 10/77 p. 87
		'78 "A" Body Cutlass, Grand Prix, Century, Monte Carlo, Chevelle.							
	Ford	'78 Granada, Monarch							
Ford	Ford	'74 + MY Ford and Lincoln-Mercury small cars.- Pressure tubes for polygel mitigator energy absorbers (PGMs). PGMs are bumper shock-absorbing devices designed to minimize collision damage in low-speed impacts. Fasten between bodies and bumpers.		PGM				4 BU	AN 9/19/77 p. 43

FIGURE B-2. BUMPERS WORKSHEETS

BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BU page 2

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Union Carbide. Owens Corning Fiberglass. USM.	GM	Development stage. Fender that return to its original shape after impact could be produced in scale within 3-4 yrs. Technology and machinery still lacking. GM and chemical companies studying effect of glass fillers on both properties of polymer and RIM process. Glass fillers add hardness, etc., and improve interface between Urethane and steel. May have problem with abrasion that use of glass filler creates in lines and tooling, and increased mold wear.	RIM (reaction injection molding.)	Urethanes possibly with glass fillers.				4 BU	WAR 10/3/77 p. 317
	VW	'78 VW Dasher Polyurethane bumper not requiring additional energy conversion and reinforcement devices. Can be used as energy absorbing elements for a 5 mph barrier impact.	RIM	Polyurethane	15% less than steel bumpers with hydraulic shock absorbers		More mpg.	4 BU	AE 10/77 p. 54
		Bumpers for 1978 cars: list attached.						4 BU	WAR 9/16/77 p. 1

FIGURE B-2. BUMPERS WORKSHEETS (Continued)

BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
	Ford	'77 Pintos and Bobcats		New, high yield strength aluminum	80 lbs. less.			4 BU	AN 1977 Market Book p. 22
USM Corp.	GM trucks	New bumpers involve injection molding 11 different parts. Bumpers made in sections - 3 for front, 5 for back bumpers. Will sustain impacts of slightly more than 5 mph without damage. GM advanced design bus (ADB)	2500 ton injection molding machine	Polyester-reinforced rubber.	Reduced			4 BU	AMM/MN 10/17/77 p. 5
	GM	'79 models (specific models not indicated) 1st attempt for chrome-coated plastic bumpers by sputtering. Previously considered technologically impossible. Would be major threat to bumper market for steel and alum. and conventional chrome plating. Testing sputtered chrome-plating on various parts and under various conditions, including impact. Conventional chrome-plating cracks under impact, partly because of pronounced differences between hardness of coating and bumper.	Chrome sputtering system	Chrome-coated plastic. Both rigid ABS and soft thermoplastic Urethane to be tested.				4 BU	AMM/MN 10/24/77 p. 22

FIGURE B-2. BUMPERS WORKSHEETS (Continued)

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
		New: 46 lbs. and 45,000 psi HSLA steel Other benefits: 1) lower fabrication and assembly costs. 2) forming dies needed only for face bars 3) do not need joining operations for assembling reinforcements to the face bars.							
	GM	Downsized intermediate '78 have chrome-plated steel bumper face bars backed by alum. reinforced bars on both front & rear.		Chrome-plated steel bumpers backed by alum. reinforced bars.				4 BU	AMM/MN 6/20/77 p. 15
	Most '78 downsized intermediate cars	Chevy Chevelles, Olds Cutlass, Buick Century, & Regal HSLA material with minimum yield strength 55,000 psi. Bumpers similar in design & makeup to all metal units on '77 GM standard cars.		Alum. alloy 7046 or 7021 or 7106.					
		WAW: Monte Carlo; Camaro & LeMans = 8% U.S. unit volume production Jan.-May 1977. Other GM intermediates = 18%. Total GM mid-size cars (excluding Camaro)-23.13%.							
	GM	Pontiac LeMans, Monte Carlo, Grand Am, Chevy Camaro have soft nose bumpers.		Urethane				4	AMM/MN 6/20/77 p. 15

FIGURE B-2. BUMPERS WORKSHEETS(Continued)

BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BU page 5

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
	GM	GM will build soft front end internally Casey (Pres., McCord Corp.) says 6% '77 have soft front and/or back. 12% in '78 MY. He projects 30% by 1980 ($192-200 million in business for mfg. soft ends).		Urethane	lowers weight			4 BU	AI 5/15/77 p. 13
		'78 Chevy Monte Carlo-front end '78 LeMans & Camaro-soft front end & tail (first time) '68 Pontiac GTO-first soft front '68 Bonneville-Urethane rear							
	Ford	'70 Mustang- soft front '73 Mustang-soft front & back							
	GM	'73 to '76 Laguna '72 on Firebird '74 on Corvette '74-'76 Grand Am '75 on Monza							
		Originally used for styling. Now safety and oil embargo emphasize weight savings.							
	Chrysler Fury-Monaco MY '78½	Increase yield strength 10,000 psi. 1st one-piece bumper used by Chrysler.		HSLA steel	23 lb./car (old = 69 new = 46)			4 BU	AMM/MN 6/20/77 p. 14
		Old bumpers (2 piece steel bumper, w/major elements being chrome-plated face bar ahead of a full-length reinforcement bar) weighed 69 lbs. and steel face bar yield str = 30,000 psi. Full-length mild steel backing bars 25-30,000 psi.				lower tooling cost			

FIGURE B-2. BUMPER WORKSHEETS(Continued)

BUMPERS

WORKSHEET

CTP - MCI 10/24/77

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Reynolds	Ford '77 Pinto & Mercury Bobcat			Aluminum	bumper 67 lbs. less. car 75 lbs. less. 55% from 1976 models			4 BU	WAW 2/77 p. 72
	Chrysler	Testing		Chrome-plated alum. bumpers	60-70% in weight			4 BU	WAW 5/77 p. 66
		NHTSA Chief Claybrook and bumpers 3 alternatives one year delay: GM argued that making changes w/only 1 yr between would lead to irrecoverable costs. Ford wants to mesh bumper changes w/fuel economy design changes. 10 mph hit = 4ximpact forces of 5 mph. Claybrook acknowledges that there are higher priorities-health and safety, fuel economy.						4 BU	AN 6/20/77 p. 1

FIGURE B-2. BUMPER WORKSHEETS(Continued)

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
	Ford 1/5 of Panther line MY '79 new smaller standard size	Ford & Chrysler '79 MY -- 1st U.S. production. Ford produce about 10,000 chromed alum. bumpers on pilot-plating line in Monroe, Mich. Additional bumpers supplied by outside vendors.	Alston 80(with cyanide) or Alcoa 661 process (w/o cyanide).	Chrome-Plated alum. rear bumpers.				4 BU	AMM/MN 5/23/77 p. 24
	Ford '77 Pinto & Maverick			Anodized alum.				4 BU	AMM/MN 4/18/77 p. 41
	GM '78 Pontiac LeMans	Current front end of steel, alum and plastic to be one piece soft-plastic assembly.		Soft urethane bumpers and front ends.					
	'78 Chevy Monte Carlo	All plastic front end. Previously, steel bumpers and hood extensions with zinc die cast end caps.							
U.S. Steel		Meet 1980 MVSS.		HSLA steel	compete with plastic.				
		HSLA bumpers designed to allow light weight impact - resistant bumper system that could still be chrome plated for bright metal look.							
		Recent ban on importing chrome from Rhodesia - still available, costlier				higher cost			

FIGURE B-2. BUMPERS WORKSHEETS (Continued)

BUMPERS

CTP - MCI 10/24/77

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Mobay Chem. Corp. or Cincinnati Milacron,Inc.	Ford '79MY Ford Mustang III Mercury Capri III	Utica, Mich. trim plant. Production & laboratory system for development future applications. RIM process fastest growing plastic fabricating technique for large-size components in U.S. auto industry. Speed, precision, compactness. Plastic fascias, unlike metal front & rear end system, will self-restore or recover from most impacts & won't rust.	RIM 5 clamping machines (or presses) & I chemical metering machine for production lab system - I-2 presses.	Plastic fascia - soft urethane front ends.		Ford costs $700,000-$1,000,000 both systems.		4 BU	AMM/MN 4/18/77 p. 16
Houdaille Industries in Oshawa & Huntington (W. Va.)	Chrysler '78 MY Plymouth Volare, Dodge Aspen	Plans not mentioned publicly. 55-60,000 psi range. New bumpers will save considerable weight and will be strong enough to eliminate need for full-length reinforcement bars behind the facings.		High strength chrome-plated steel on front & rear bumper face bars.	"considerable"			4 BU	AMM/MN 6/26/77 p. 11
	GM Chevy Chevelle, Olds Cutlass, Buick Century & Regal	Downsized A-body. HSLA steel and backed up by alum. reinforced bars to be used on both front & rear.		Chrome-plated high strength face bars.					

FIGURE B-2. BUMPERS WORKSHEETS (Continued)

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
		consumer information program for bumper standards insurance. Also suggest bumper standard exceeding 5 mph and multi-purpose vehicles (now exempt). Latter under consideration.							
U.S. Steel		Based on "limited access" design, using strategically placed bumper guards to redirect impacts to points where accommodation has been made to minimize denting. Meets 1980 govt. specs.		HSLA steel 0.052" thick	2% gross vehicle weight on large cars. 10 lbs. small cars.			4 BU	AI 8/1/77 p. 72
Oshawa (Ontario) division Houdaille Industries	Chrysler '79 R-body	Alstan 80 process, using cyanide, developed by M&T Chemicals, Inc. Rahway, NJ. Aluminum will be supplied by Aluminum Corp. of Amer. and Reynolds Metals Co. Nickel-chrome plating of about .002 inch. 50 bumpers tested (incl. 15 suburban Detroit police cars). Houdaille supplied bumpers used on Plymouth Fury models. Gulf & Western Mfg. Co. supplied units on Gran Fury models (not serious contenders).	Fabricated. Alst. 80 technique for pretreat. bumpers prior to plating uses cyanide.	Nickel-chrome plated stamped Al bumpers. Al alloy 7146. (or alloys 7021 or 7029).	Plating slightly heavier than on conventional plated steel (.002 in.)			4 BU	AMM/MN 7/4/77 p. 1
	Ford '79 Ford & Mercury station wagons	Ford: 100,000 cars w/extruded chrome plated front bumpers & anodized rear bumpers. Mercury: 25,000 w/plated rear bumpers & anodized front bumpers.						4 BU	AMM/MN 7/4/77 p. 1

FIGURE B-2. BUMPERS WORKSHEETS(Continued)

WORKSHEET

CTP - MCI 10/24/77

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
		5-MPH safety bumper. NHTSA public hearing NHTSA Chief Joan Claybrook's 3 options: 1) delay of no-damage bumper requirement until '81 MY 2) delay of no-damage bumper requirement until '81 MY and consumer info. program to become effective in Sept. 1978. 3) indefinite delay of no-damage standard and a consumer info. program Phase I: limit amount of damage to body panels - 1978 deadline. Phase II: limit damage to bumper itself. 1979 deadline extension 1 yr. for Ford & VW asked. 1979 deadline extension indefintely for GM, AMC, Chrysler asked. All recommended NHTSA undertake field studies to determine whether lab bumper test procedures correlate actual field experience before agency orders Phase II requirements. Value of consumer info program questionable - cost of repairing damage caused by 5 or 10 MPH crashes vary w/particular car & circumstance. Insurance industry wants original order enforced - no substitution of						4 BU	AN 8/15/77 p. 3

FIGURE B-2. BUMPERS WORKSHEETS (Continued)

BUMPERS CTP - MCI 10/24/77 BU page 11

WORKSHEET

BUMPER MFG.	AUTO MFG.	BUMPERS	TOOLING	MATERIALS	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
VW	VW 1978 Dasher	1978 VW Dasher - introduce in U. S. 10/13. Replaces steel bumpers w/hydraulic shock absorbers. Construction: U profiles which are reinforced by integral vertical ribs in the center section, and verticle, horizontal and diagonal ribs at corners. Openings in surface of bumpers could be provided for turn signal lamp mountings. Foam portion of each bumper is attached to steel supporting beam by means of a narrow mounting bar on top, and bolts at the bottom mounting bar is a steel unit that's welded onto the beam. Plastic bumper designed as to enable input kinetic energy from low-speed impacts to be transferred w/o permanent deformation to the steel supporting beam and car body structure.	RIM	Polyurethane Steel beams behind bumpers to support plastic units and help absorb impact forces.	15% less	Raw Materials less		4 BU	AMM/MN 10/3/77 p. 16
	GM 1978 Chevy Monte Carlo	Guideflex bumpers		Painted plastic outer skin and bright metal trim.	100 lbs. less than '77 MY			4 BU	AN B/29/77 p. 3

FIGURE B-2. BUMPERS WORKSHEETS (Concluded)

CONTROL DEVICES WORKSHEET CTP - MCI 11/17/77 CO page 1

TYPE	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Engine Control System	Electronic spark advance system (lean burn) installed on experimental Dodge Charger 225 CIO 6-cylinder engine. Lean burn meets Federal pollution standards without need of catalytic converter and unleaded gasoline.		Chrysler	Dodge Charger experimental car.		Lean burn 25.2 mpg. (highway) 17.4 mpg. (city)	4 CO	MT 4/77 p. 20
				'76 Chrysler Cordoba first lean-burn		non-lean-burn 21 mpg (highway) 16 mpg (city)		
Vehicle Control System	Federal Screw Works developing instrument panel with electronically triggered voice messages that will inform car drivers about as many as 27 different diagnostic problems as they occur. 1st application of voice system was GM's computer Recall Identification System (CRIS) used by dealers to learn what safety recall campaigns a particular car was involved in.	Federal Screw Works	GM Ford		8 x what manufacturers's will pay		4 CO	AI 5/1/77 p. 7
Air Injection Pumps Emission Control Device	Air pumps are emission control devices designed to inject air into exhaust ports of engine cylinder heads, enabling the combustion process to oxidize more pollutants than normal. Will be used in 1980s, probably in combination with electronically controlled carburetors or fuel injection systems and three-way catalytic converters to meet stiffer regulations. Aluminum, steel, iron.		GM	California model, Cadillac Sevilles			4 CO	AMM/MN 10/24/77 p. 13
Electronic Engine and Vehicle Control	3 categories: control devices, displays and diagnosis, and interconnection systems (wiring). Advances are being made in digital microprocessor control for engines and car, but auto makers require cost effective and reliable systems before they'll replace a current working system.						4 CO	AI 3/1/77 p. 18

FIGURE B-3. CONTROL DEVICES WORKSHEETS

CONTROL DEVICES WORKSHEET CTP - MCI 11/17/77 CD page 2

TYPE	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Emission Control	1981 standards will bring in a closed-loop fuel control system and electronic engine controls, along with a dual converter system.		GM		Car $25 by 1980 Additional $140-160 in 1981.		4 CD	WAR 8/20/77 p. 275
Emission Control	Mfgs. must meet both fuel economy standards and safety and service laws and regulations that hurt fuel economy. Higher temperatures: engines more efficient performance and lower hydrocarbon (HC) and carbon monoxide (CO) emissions but high oxides of nitrogen (NO_x) emissions. Need to keep air/fuel ratio at 14.7:1 (±.05) for catalytic converters. Electronic sensors needed. Conventional mechanical systems affected by too many variables - road speed, load, temperature.		Chrysler		$1 invested in electronic voltage regulators. Saves customer $9 in replacement costs. $1 invested in electronic ignition. Saves $4.		4 CD	AN 8/29/77 p. 8
Engine Control	Control 2 major operations of engine 1) firing of spark 2) distribution of fuel to combustion chamber Emission controls must last 5 year or 50,000 with proper use and maintenance -- easier for manufacturer if electronic components harder to adjust.							
Electronic Control	Anticipates general rather than dedicated electronic systems. Projected that complete chip set for electronic regulation of ignition, fuel and EGR will have total cost of $10-20 by 1980.						4 CD	AE 4/77 p. 24

FIGURE B-3. CONTROL DEVICES WORKSHEETS (Continued)

CONTROL DEVICES WORKSHEET CTP - MCI 11/17/77 CD page 3

TYPE	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Electronic Ignition Control Units	400,000 spark computers 300,000 digital clocks 2,000,000 electronic ignition units produced at Huntsville, Ala. plant in 1977. Smaller version ignition control unit will be produced for first time for cars in France and Spain.		Chrysler	1977 MY			4 CD	WAR 10/17/77 p.' 331
Electronic Control	May never build cars in the single microprossor: 1) system wuld be more complicated than needed. 2) probably lack fail-safe features seen as key component electronic design.		GM	'78 MY			4 CD	WAR 9/26/77 p. 307
Engine Control System	3 engine-control electronic systems on '78s. - closed-loop fuel control - electronic spark control - electronic spark selection in addition to an automatic level control. Electronically-tuned radio features digital dial which doubles as a clock.							
Emission Control	Catalytic converter has 2 sections: - forward part: 3-way oxidation/reduction catalyst. - farther part: conventional oxidation unit.		Ford	'78 Fairmont/Zyphyr			4 CD	WEU 9/2/77 p. 3
Electronic Engine Control	Plans to install in about 30,000 cars equipped with small V-8s during 1978 model year - Nationwide. Interactive system is controlled by a digital microprocessor, adjusts both spark advance and exhaust gas recirculation.	Ford Electrical and Electronics Div. Tokyo Shibaura Electric Co. Essex Group of United Tech.	Ford	'78 Versailles			4 CD	WEU 9/2/77 p. 2
Electronic Control	Descriptive history of advances in electronic vehicle and engine control						4 CD	WAW 11/77 p. 31

FIGURE B-3. CONTROL DEVICES WORKSHEETS (Continued)

CONTROL DEVICES WORKSHEET CTP - MCI 11/17/77 CD page 4

TYPE	NOTES	SUPPLIER	AUTO MFG.	MODEL	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Tripmaster	Tripmaster is first true high-performance computer ever offered for sale in automobile. Operations include 1) digital instruments - speedometer, fuel level remaining in gallons, engine coolant temperature, time of day, etc. 2) make almost any desired time, speed and distance calculation. 3) fuel consumption. 4) miles to empty fuel information.	GM	GM	'78 Cadillac Seville	Expensive		4 CD	MT 10/77 p. 106
Electronic Fuel Injection. Engine and Vehicle Control.	Initally designed to play on tasks that aren't essential to safety and operation of car but could take over electronic fuel injection and many other control functions. Planned production in 1978 is 20,000 units. (1977 production Sevilles was 40,000.)							
Engine and Vehicle Control System	New electronic applications perform some jobs which simply could not be done without electronics. Ford new applications include engine controls, vehicle controls and entertainment. Previously introduced features include anti-skid brakes, speed control, ignition system, illuminated entry system and automatic headlight control.		Ford	'78 Versailles, '78 Lincoln Continental Mark V			4 CD	AN 9/26/77 p. 8
Engine Control System	New Electronic spark selection control automatically advances or retards spark as driving situations dictate. Electronic control unit for electronic fuel injection changed for improved driveability at high altitudes. Load levelling system.		GM	Cadillac Seville Seville, Eldorado, Brougham, deVille (optional)		Up 1 mpg.		
	Lean Burn ignition system now available in all the company's 8-cylinder engine families.		Chrysler					
Engine Control System	Predicts 10% cost of automobile in 1985 will be electronic control devices. Introduce analyzer that can trouble-shoot 60 different engine functions in less than 4 minutes and supply printed information to the mechanic telling him what to replace.		Chrysler	1978			4 CD	WAR 8/8/77 p. 1

FIGURE B-3. CONTROL DEVICES WORKSHEETS (Concluded)

ELECTRICAL SYSTEM

WORKSHEET

CTP - MCI 11/17/77

ES page 1

COMPONENT	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCE
		Increased use of silicone cable in high temperature areas.					Silicone sets initially cost more but overall performance superior.		
		Mid-late '60s silicone rubber spark plug boots became standard.							
		Electronic ignition package first OEM use of EPOM-insulation-plus silicone jacket combination cable.		Chrysler					
		HEI system used EPDM/silicon cable.		GM				4 ES	AI 1/1/77 p. 34
		Total silicone insulated cable.		Ford	Some 1975 models, 1976 and 1977.				
Battery for Electric Car	Zinc-Chlorine. Sodium-Sulfur. Lithium-metal sulfides.	Gulf & Western expects zinc-chlorine battery to meet EROA (Energy Research & Development Administration) goals of powering a car 150 miles at average speed of 55 mph and top speed 75 mph. Expects electric vehicles to have modest but solid share of road - 10% in 15 or 20 years.	Gulf & Western. Hooker Chemical Div. of Occidental Petroleum Corp.					4 ES	WEU 7/22/77 p. 6
Battery	Lead-Strontium Alloy	Advantage claimed is reliability in production which has helped control production costs and hold prices at present levels.	Globe-Union	Ford	'78 Lincoln-Mercury Versailles			4 ES	WEU 7/22/77 p. 6
Battery Grid Design		Redistributes lead mass into webbed, wheel-spoke pattern that puts heavier lead grid wires on spokes near the lug. Power-to-weight benefits, overcharge protection.							

FIGURE B-4. ELECTRICAL SYSTEM WORKSHEETS

ELECTRICAL SYSTEM WORKSHEET CTP - MCI 11/17/77 ES page 2

COMPONENT	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCE
Lights	Fiber optics; Dupont Crofon	Fiber optics used to transmit light to small areas on cars such as dashboards in trucks which need numerous switchplates illuminated in which small bulbs would be impractical. Advantage to eliminate size and heat of bulbs in small areas, especially among delicate electronic components. Ribbon fiber - strands woven together on textile type machine. Monofilament - single strand of material thicker than other 2. Bundle - group of strands held together in a casing similar to stranded copper wire. Ribbon fiber optic system most promising because it enables light to be transmitted along its entire length. Others only permit light to be used at their end point. Up to 6 different paths can be illuminated from one bulb with ribbon optic fibers and light can be bent, twisted, or tied into knots with little effect on light being transmitted.	Dupont Packard Electric Div. of GM.	GM Intl. Harvester	GMC trucks Heavy duty trucks		Cost Advantage	4 ES	AI 2/1/77 p. 49
Automotive Ignition Cable	See list attached	Higher voltages produced by new electronic ignition devices and rising temperatures under the hood from leaner burning, power options and crowded hood conditions have created need for high temperature dielectrics. Also created need to increase cable size from 0.28 to 0.31 inches and produce more insulation.						4	AI 1/1/77 p. 34

FIGURE B-4. ELECTRICAL SYSTEM WORKSHEETS (Continued)

ELECTRICAL SYSTEM WORKSHEET CTP - MCI 11/17/77 ES page 3

COMPONENT	MATERIAL	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	MEDIA REF. BOOK NO.	REFERENCE
Battery	Silver-Iron	Offers highest energy density per pound of any battery available. Pilot-scale production could expand for broad commercial applications. Amount of silver same as in silver-zinc battery.	Westinghouse Electric Co.					4 ES	AMM/MN 10/24/77 p. 2
Battery for Electric Cars		Battery research as prelude to electric car. Over 400 electric vehicles: U. S. Postal Service Carts, golf carts, electric taxis in England.		AMC				4 ES	MT 10/77 p. 17
	Zinc-Nickel Oxides Lithium-ion Sulfide	Testing zinc-nickel oxide batteries; lithium-iron sulfide. Driving range increase 30-200 mi. over normal lead-acid unit. Energy packed in 1/5-1/10 space.		GM					
	Zinc-Chlorine battery with petroleum/chemical combine	One 40-kilowatt-per-hour battery will drive vehicle, putting out enough electricity to operate a 15 horse power motor continuously for 4 hours. Enough to drive 2500 lb. car with 4 people 200 miles (50 mph). Fit under front and rear seats in general area of today's exhaust systems.	Gulf-Western			Weigh 800 lbs. 30 in.wide x 14 in.high.x 5 ft. long.		4 ES	MT 10/77 p. 17
		20 diehards plus an extra one for accessories adapted Fiat 128. Removed radiator, gas tank, gas lines, etc. car will run 60-90 miles without recharge. Can accelerate up to 70 mph in short bursts, can maintain 55 mph speed limit. Not for commercial production.	Sears			100 lb. more than Fiat with engine.			

FIGURE B-4. ELECTRICAL SYSTEMS WORKSHEETS (Concluded)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77- ED p. 1

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
	Zinc		Pioneer conducting research in maintaining and expanding use of zinc by auto industry under a contract with ILZRO (Intl. Lead Zinc Research Organization). Breaking cars down by components. Future use in fuel-injection systems important to zinc manufacturers if carburetors are phased out as too inefficient since two of three die castings used for carburetors are zinc. Possible long-term use of zinc include 1) super plastic zinc in fuel in fuel-injection system. 2) new alloy ILZRO 16 for moving parts under car hood (such as pulleys and camshaft sprockets.)	Pioneer Engineering & Manufacturing Co. (research)						4 ED	AMM/MN 5/23/77 p. 25
Camshaft Sprockets	Zinc						½ wt. of iron	same as iron			
Brake Master Cylinder	Zinc	Die Casting	Replace cast iron.				½ weight	same as iron			
Seatbelt Buckle			Since switched from zinc die casting to five steel stampings, want to recapture market.					additional 18¢/ buckle.			

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 2

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Axles cont.			7.5 inch unit - different dimensions and characteristics than compact. (replace 8 in.)	Apex Corp. Bendix Machine Tool Corp.	Ford	'79 downsized standard models replacing LTD and Marquis lines.				4 ED	WEU 6/10/77 p. 1
			Optional axle with 8.5 in. ring gear (replace 9 in.)		Ford	'79 downsized standard LTD and Marquis Station Wagons					
			Redesigned 6.75 in. axle		Ford	'79 Mustang III, Capri III, Pinto, Bobcat.					
Rotary Engine			Discontinued research and development on rotary engine primarily because rotary engines couldn't achieve low emission levels and fuel economy of current engines.		GM					4 ED	AI 5/15/77 p. 11
			Markets 3 types of engines: rotary, conventional piston, diesel.		Mazda				32 mpg. highway. 20 mpg. city.		

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 3

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
	Crankshaft: steel	Forged								4 ED	AE 6/77 p. 17
	Bearing caps: Aluminum	One-piece casting									
Body	Galvanized steel		Body								
	Aluminum		Doors, hood, and bolt-on front mudguards.								
	Foam covered aluminum		Bumpers								
Engines Cylinder Blocks, Exhaust Manifolds	thinner than normal cast iron		Over next 3-4 years, Chrysler will reduce size of engines primarily through use of thinner-than-normal construction of cast iron components and switch to aluminum from iron in other areas. (blocks, heads, manifolds, water pumps). Engine package includes single-barrel carburetor, cast iron head, manifolds, torque converter.		Chrysler		225-CID 6-cylinder reduced 105 lbs. from 542 lbs. 318 CID 8-cylinder reduced 70-120 lb. from 614 lbs. (engine package)			4 ED	WEU 6/10/77 p. 1
Intake Manifold	Aluminum										
Cylinder block	Aluminum		318 CID V-8 cylinder.			Optional by 1980.	50 lbs. less.				
Axles			Rear drive unit 7.5 inch. (Replace 8 in.)	LaSalle Machine Tool Inc. Cross Co.	Ford	'78 Fairmont and Zephyr compact	Lighter	Tooling cost $50-100 million		4 ED	WEU 6/10/77 p. 1

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 4

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Engine			Ford selected 3 assembly machine builders to construct major sections of V-8 engine assembly line for expanding 302-cubic-inch engine manufacturing facilities in Cleveland. Three suppliers chosen, instead of usual one, to assure delivery dates of last quarter 1977. Ford will use 302 CID engine in downsized standard cars instead of larger 351, 400, 460 CID V-8s.	Wilson Automotive Co. Automatic Production Systems. Visitrol Engineering Co.	Ford	'79 MY downsized std. cars '76 + Intermediate cars. Optional in smaller cars.		$10 million assembly line		4 ED	AMM/MN 2/21/77 p. 4
Intake Manifolds	Aluminum	Die Castings	Contract awarded for production to start March, 1978.	Hayes-Albion Corp.	Ford					4 ED	AMM/MN 2/21/77 p. 4
Intake Manifolds	Aluminum		Letter to editor citing previous use of aluminum manifolds in Chevrolet V-8s, especially the LT-1/Z-28 special high performance 350 4-V, L-88 427-4V, and a few 454-4V V-8 engines (primarily Corvette and Camaro.) Letter citing problems Chris-Craft had in early 1960's in fitting aluminum intake manifolds to Chevy blocks.		GM					4ED	WAW 2/77 p. 13
Engine	Cylinder block: aluminum high-silicon alloy 390 Pistons: aluminum coated with steel.		Light alloy water cooled V-8 has rear transaxle to approach ideal 50;50 front/rear weight distribution despite front-end mass of big engine. Engine has fuel injection and electronic ignition. Cylinder block not need cast iron liners.	Reynolds	Porsch	Porsche 928				4ED	AE 6/77 p. 17

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS

WORKSHEET

CTP - MCI 11/17/77 ED p. 5

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA PEF. BOOK NO.	REFERENCE
Radiator Sensor			Developed sensor capable of determining corrosivity of engine coolers in radiators. Device may be particularly useful in future cars equipped with aluminum radiators and engines which is more susceptible to corrosion than copper.	Texas Instruments.						4 ED	AMM/MN 5/9/77 p. 5
Diesel Engine			Performance of 350 CID diesel V-8 about same as 260 CID V-8 gasoline engine. May have problem with emission of NO_x if level permissible in 1978 lower than 1977 since engine operates at higher temperature.	GM	GM	'78 Olds. Chevy and GMC trucks.			25% improvement diesel mpg. highway = 29 city = 20 350 V-8 gas: highway = 21 city = 16	4 ED	MT 5/77 p. 19
				Nissan	Chrysler	'78 trucks					
				Peugot	Ford	'78 Granada in Europe					
					AMC	'78 Jeep overseas					

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 6

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Spark Plug		Plasma-jet	Development stage and would require several years before use in auto engine. Plasma-jet spark plug would require different electrical system, replacement of today's high-nickel electrodes with tungsten carbides.	Bendix Corp. Associated Engineering (Britain)	Ford					4 ED	AMM/MN 8/15/77 p. 5
Carburetor			V.P. Bendix Corp. predicts end nearing for standard carburetor as demand for precise fuel metering increases. By 1981, Bendix will market system consisting of sensors, actuators, fuel injectors and central electronic "brain", with digital electronics in central computer and single point ignition. Single point injection ready.	Bendix Corp.						4 ED	WAW 8/77 p. 25
Steering Housing	Steel	Stamped	Rack-and-pinion-steering housing undergoing road test on a 1977 subcompact.	U.S.Steel (not manufacturer of component.)			1.43 lbs. less than aluminum casting/ steel tubing.	Reduced machining costs.		4 ED	AI 6/1/77 p. 42
Intake Manifold	Aluminum		1st time for Ford who will install on some V-8 engines.		Ford	'78 MY	Aluminum intake pump and manifold = 20 lbs. less.			4 ED	AMM/MN 4/25/77 p. 13

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 7

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Axles			Axles lighter and more efficient than units they're designed to replace.		Ford	'78 Fairmont/ Zephyr compacts. '79 downsized LTD, Marquis. '79 Mustang III, Capri III, Pinto, Bobcat.	Lighter	Tooling cost $50-100 million		4 ED	WEU 6/10/77 p. 1
Carburetor			John and Albert Csonka (age 79 and 77) seeking funding from ERDA to build and test improved carburetor. Initial support came from chairman of Dept. of Industrial Arts and Vocational Education at Buffalo State (as a community service).						9.1-26% fuel saved compared with Rochester carburetor	4 ED	IR 6/77 p. 134
Intake Manifolds	Aluminum Alloy 380	Electron beam (EB) welding. Die Casting.	1st 2-piece aluminum intake manifolds using electron beam welding rather than laser welding or mechanical fastening techniques. Plan to phase out cast iron manifolds. Probably will be adopted by other auto mfgs. if welding technique can be worked out. Intake manifolds too complex to be die cast economically in one piece but 2-pieces well suited to die casting equipment, which is plentiful.	Leybold Heracus Vacuum Systems Inc. Allen-Bradley Co. (equipment).	Chrysler	6 cylinder engine models '78 MY.	2/3 lighter than cast iron units.			4 ED	AMM/MN 7/18/77 p. 12

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 8

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Driveshaft, etc. cont.			Elastic modules of 32 million psi and tensile strength of over 400 thousand psi. Best applications are where the filament in continuous form can be used.							4 ED	AI 7/1/77 p. 33
Front Fascia	SMC (sheet molding compound) is glass fiber Aluminum HSLA steel (steel with traces columbium and vanadium)		Chrysler engineer Winders "There's a fixed relationship between overall vehicle weight and drive-line weight. The curve of that relationship is pretty flat." Effort to reduce both sprung and unsprung weight - as in wheels. See attached list for Chrysler Chassis Weight Savings Through Material Substitution.		Chrysler					4 ED	AI 7/1/77 p. 33
Diesel engine			Computer simulation of hypothetical diesel engine AD-209 features variable compression ratio and exhaust turbocharging. Simulate for mileage and emissions. No engine built.	Teledyne Continental Motors with ERDA support.			Wt.=495 lbs. (include fan, starter, alternator)			4 ED	AE 7/77 p. 40
			Results of computer simulation.				3000 lb. car 3400 lb. car 3700 lb. car		30.3 mpg. 29.1 mpg. 28.3 mpg.		

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 9

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
	Aluminum Case		T-10, 4-speed, manual transmission	Warner Gear	GM	'77 Chevy Corvette, Z-28 Camaro, Pontiac Trans AM	70 lbs.			4 EO	AI 7/1/77 p. 33
4-Wheel Drive Train			Quadra-Trac two-speed/four-speed drive transfer case (option).	Warner Gear	AMC	Jeeps	new-100 lbs. old=210 lbs. (cast iron)				
Differential			Spin-resistant differential SRO) uses lighter 7½ inch axle in place of 8½ inch axle.	Warner Gear	GM					4 EO	AI 7/1/77 p. 33
Gears	Iron	Cast	Cast nodular iron ring and pinion gear. 1st use in auto industry. Replace steel forgings on station wagons with 8-3/4 inch rear axle.		GM	'77 full and intermediate station wagons.	2.0 lb. less per gear set.				
Driveshaft and leaf spring	Graphite fiber composites		Leaf spring has some spring rate and load capacity.		Ford	'76 Granada	84% on leaf spring. (fiber = 4.5 lbs. steel = 28 lbs.)				
Driveshaft, suspension, gear, push rods, bearings, transmission supports, driveshaft yokes.	"magnamite" made from polyacrylonitrite (type AS-3)		Cost effective structural material with high stiffness, low weight, and versatility of fabrication (proven in aircraft industry). Secondary properties include vibration clamping, friction reduction, noise suppression, chemical inertness. Tremendous strength comes from the crystalline structure of the carbon graphite element:	Hercules, Inc.			Reduction in each area compared to steel. fiber=70%+ plastic=50% alum.=40-50% high strength steel=10-30%	$18/lb. raw mat. (prev. $32/lb. anticipate $10/lb.)			

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 10

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Front Wheel Drive Chain			Hy-Vo (high velocity) chain. When engine mounted transverse or longitudinal, most efficient way of coupling engine/transmission is to couple output shaft of engine to input shaft of transmission via high-speed chain and sprockets.	Morse Chain	GM	'77 Olds Toronado	Chain 30% less. new = 4.8 lb. old = 6.8 lb. chain driven transfer case single assembly = 69 lb. 2-speed = 105 lb.			4 ED	AI 7/1/77 p. 33
Transmission			T-50 transmission manual.	Warner Gear	GM	'77 Chevy, Buick, Olds, Pontiac					
	Aluminum Case		151 Cu. in., 4 cylinder, automatic transmission			'77 Pontiac Astre	93 lb. case		27 mpg combined. 32 highway.		
	Aluminum Case		T-50, 5 speed overdrive, manual transmission			'77 Pontiac Astre	65 lb. case		33 mpg combined. 41 highway.		
	Aluminum Case		SR-4, 4-speed manual transmission	Warner Gear	Ford	'74 + Mustang II Compact	58 lb. case				
			SR-4, 4-speed optional transmission vs. 3-speed.		AMC	Pacer, Hornet, Gremlin	20 lbs. less				
	Cast-iron Case		T-10, 4-speed, manual transmission	Warner Gear	GM	'57 Chevy Corvette (debut)	85 lbs.				

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p. 11

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Drive-line Components		Castings forging	Production problems solved by adding materials, traditionally.							4 ED	AI 7/1/77 p. 33
Engines	Cast iron, steel, aluminum		Heaviest component drive-line. Factors affecting weight are controlled by design, materials, manufacturing processes and cost.								
Engine/ cylinder block			In engine design, important to pay critical attention to major components -- particularly cylinder block -- since other components, such as intake and exhaust manifolds, and water pump proportionately relate.								
			Analysis reveals many areas in block from which nonfunctional material can be removed. Thin walled castings produced with interlocking cores.				3.0 lb. per block				
Engine/ torque converters	Light gauge steel	Fabricated sheets	Minor areas. Also pump, stator, turbine.								
			Numerous plastic parts do not significantly reduce wt.: valve body spindle valves, modular pistons, speedometer gears and various seals.								
Bell housing	Steel	3-stage stamping (no machining. minor grinding only).	Sheet steel bell housing.	U.S.Steel			35 lb. stamped steel 49 lbs. cast iron	Production costs reduced.			

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 EO p.12

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Diesel engine			Extra equipment includes fuel injection, two-battery electrical system, injectors, glow parts and various associated components.		GM	'78 Olds 88, 98 pickups	130 lb. increase		25% increase mpg over gas engine.	4 EO	WEU 9/16/77 'p. 4
4-Cylinder Engine	Aluminum blocks and cylinders	Die-cast blocks	Discontinued aluminum engine and Vega line. Problems in engine: poor endurance, poor design, short life, overheating.		GM	Chevy Vega				4 EO	WEU 9/16/77 p. 5
			GM expects to use aluminum more in combination with iron. Engines installed in 8 years of production = 2,459,789.			Chevy Vega, Monza, Pontiac Astre, Sunbird	Engine weight= 330 lbs.				
Spark Plug	Currently 78-90% Nickel in each electrode		Suppliers want change in electrode metals to reduce cost and dependence on nickel-rich alloys. Change would require EPA certification because spark plug is considered part of emissions control system.	Bendix Corp. GM AC Spark Plug Div.						4 ED	AMM/MN 8/22/77 p. 21
	Platinum-gold electrode plug		Largest V-8 engines.	Champion	Chrysler	1975 models		$6 plus gold (U.S. $1.25 nickel) lasted 2 x as long.			
	Iron alloys	Easier to form and weld						Less costly.			
	Tungsten and Tungsten Carbide		High temperature materials used in plasma jet spark plug					costly			

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS

WORKSHEET

CTP - MCI 11/17/77

ED p.13

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Transmission gears cont.		or any other chip-forming operation.	Higher production capacity.					cost,		4 ED	AMM/MN 10/13/77 p. 1
Intake manifolds for V-8 engines	Aluminum	Low pressure casting and gravity permanent mold casting.	Replaces cast-iron manifolds. Expected production in 1978 is 50,000 units.		Ford	'78 Granada Monarchs	30 lbs. less (alum. = 15 lbs. cast iron = 45 lbs.)			4 ED	AMM/MN 8/29/77 p. 18
Intake manifolds for V-8 engines	Aluminum	two-piece die-cast manifolds or one-piece mold-casting or one-piece sand-casting	Two-piece, die-cast manifolds assembled with electron beam welders for Volare/Aspen. Other new alum. intakes for '78 models will be one-piece made by permanent mold casting or sand casting - no welding or joining process would be required. Long range plans to convert 8-cylinder engine manifolds from cast iron to aluminum.		Chrysler	'78 Plymouth Volare, Dodge Aspen	12 lb. less on 4 door Volare/ Aspen than cast iron	Die-casting more economical tooling.		4 ED	WEU 9/16/77 p. 3
Turbo-Charger V-6 Engine			Turbocharger can pack more air/ fuel mixture into engine when more power is needed, yet run at high economy consumption rates during normal driving. Even-firing.		GM	'78 Buick Regal Coupe, LaSabre Sports Coupe			Increase mpg.	4 ED	WEU 9/16/77 p. 4
V-6 engine			New 200 cu.- inch-V6, 90 degree engine. 8 inches shorter in length than 250-cu. inch inline 6.		GM	'78 Chevy Malibu	63 lbs. less than '77 Malibu		14% increase mpg from '77 Malibu		

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p.14

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Cylinder Heads and Blocks in Engine	Aluminum	Less machining, die casting, mold casting.	Phasing in aluminum to replace cast iron in cylinder heads and block over next 10 years. By 1985, Ford expects to double its aluminum consumption from 110 lbs./car (or 30% total) to 200-250 lbs./car (6-8% total).		Ford		Weight savings 25-30 lbs. per cylinder	Lower capital investment.		4 ED	AMM/MN 6/13/77 p. 37
Cylinder Heads and Blocks	Aluminum		Design constraints with aluminum die castings. Make it more practical in short run to initially produce components as low pressure, semi-permanent mold castings.							4 ED	AMM/MN 6/13/77 p. 37
Intake Manifolds	Aluminum		Developing a single plane manifold which can be split in 2 pieces (instead of 4 or 5) and joined by welding using electron beam or laser welding. Could be ready for production in early 1980's.		Ford		2-3 lbs.	Cost effective		4 ED	AMM/MN 6/13/77 p. 37
Rocker Arms in V-8 Engines	Steel. Also studying ceramics and high performance carbon fiber-reinforced plastic.	Stamped instead of cast.	Expanding and modernizing Cleveland engine plant for stamped steel rocker arms for production in 1979 or 1980.		Ford		lighter weight	Steel less costly than carbon-fiber units.		4 ED	WEU 9/16/77 p. 3
Transmission gears		Cold extrusion techniques in place of hobbing, pot broaching	Developed new technique for roughing out transmission helical gears. Plan to produce on pilot line in 1979 on forthcoming FIOD (Ford Integral Overdrive) automatic transmission manufacturing program.		Ford			Uses less energy, less floor space, reduce overall tooling		4 ED	AMM/MN 10/13/77 p. 1

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 EO p. 15

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Diesel Engine	Cast Iron Inlet Manifold		Modifying its 350 CIO V-8 gasoline engine to perform as a diesel.		GM	Olds	Engine weighs 111 lbs. more than 350 CIO Olds V-8 (diesel wt. 728 lbs.) Car weighs 135 lbs. more (2 batteries, no catalytic converter).			4 EO	MT 10/77 p. 84
Diesel engine gaskets			Improved gaskets for diesels. Because of much greater pressures involved in sealing diesel heads and block, ordinary embossed metal gaskets weren't suitable. Currently, Fel-Pro only supplier for 100,000 GM Diesels.	Fel-Pro	GM	Olds				4 EO	WAW 10/77 p. 95
Rear Axles			Expanding production facilities in Michigan.		Ford	'78 Fairmont/ Zephyr	9-28 lbs. less per car.			4 EO	WAR 9/26/77 p. 308
			Expanding production facilities in several plants.		GM Canada						

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 ED p.16

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Diesel engine	Conventional metals for all parts except camshaft and hydraulic lifters.		Diesel engine is robust engine that uses the heat of compression to fire its kerosene-like fuel. Compression ratio increased to 22.5:1. Olds diesel carries 7 qts. of oil instead of 5 and requires changing of oil every 3000 miles. Need second battery and starter with 30% higher output.		GM	'78 Olds Delta 88, 98, Station Wagon	180 lbs. more than gas engine. Curb wt. 4125 lb.	$700-$900 more per car for Olds Diesel.	EPA mpg 21 city, 30 highway, 24 combined. 25% higher than gas V-8.	4 ED	R&T 11/77 p. 63
Rear Axle	Iron	Cast	New nodular iron hypoid gears comparable to steel gears in durability. Initial annual production of gears expected to be 1.1 million sets.		GM	Jan. 1977 stand. on full size station wagons, most Cadillacs, some others.	2 lbs. saved on Pontiac gear sets.			4 ED	WAR 10/17/77 p. 331
V-8 engine	Aluminum silicon block		New V-8 engine.		Porsche Mercedes Benz	Porsche 928 450 SLC coupe.				4 ED	WAR 10/3/77 p. 317
V-6 engine			Fuel-saving V-6 engine made possible by the weight-savings and redesign.		GM	'78 Chevy El Camino pickup	600 lb./car less 80 lb./engine less			4 ED	AN 10/3/77 p. 8

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Continued)

ENGINE AND DRIVE TRAIN PARTS WORKSHEET CTP - MCI 11/17/77 EO p.17

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MOOEL	WEIGHT REOUCTION	COST	FUEL ECONOMY	MEOIA REF. BOOK NO.	REFERENCE
V-8 Engine	Aluminum with Silicon	Reynolds technique used in Chevy Vega	New V-8 engine has liquid instead of air-cooling and 90-degree "V" instead of horizontally opposed cylinders.		Porsche	Porsche 928	Dry engine, radiator, assessories weight 200 lbs. less than U.S. iron V-8.			4 ED	WEU 6/10/77 p. 8
Front Wheel Drive			FWD cars designed to maximize the benefits of driving the front wheels.					tooling costs high if convert from rear drive. Comparable if mfg. from scratch		4 ED	R&T 11/77 p. 45
			FWO on smallest and mid-range cars, rear drive for larger-cars. May depend on size.		Fiat						
			Advantages of FWO include: 1) lower, flatter floor possible with more useful space. 2) different possible positions for engine placement (transverse, sideways) which may save space, lower center of gravity, facilitate assembly and improve accessibility. 3) greater ride comfort 4) no driveline to rear 5) independent, lighter suspension systems.								
			U. S. manufacturers shifting to FWO beginning with compacts may be beginning of trend to complete FWD.		GM	'79 MY compacts					
					Chrysler	'78 MY sub-compacts Plymouth Horizon Oodge Omni					

FIGURE B-5. ENGINE AND DRIVE-TRAIN PARTS WORKSHEETS (Concluded)

FASTENERS

CTP - MCI 11/15/77 FA p. 1

WORK SHEET

SUPPLIER	AUTO MFG.	FASTENERS	MATERIALS	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
		Locking devices: prevent fasteners becoming loose. Patches, trilobular heads, conical washers, self-drilling screws, more are used. Many of fastener holes on a car drilled larger than necessary (makes up for variances in production) - lock washer on nut locks it. Single piece locking fasteners - More effective locking. Simpler assembly for single piece. Micro-encapsulated fasteners coated with microscopic adhesive capsules on application; some of capsules break and bond, giving secure fit. Popular in interior trim applicators where fastener is going through plastics.				4 FA	AI 5/1/77 p. 20
	Chrysler	Standardization Total vehicle standardization not affect fastener industry but fastener standardization effective. 3 yr. program std., different types of fasteners used cut 20%. But new design (i.e. FWD) require diff. bolts can't use traditional stds. Auto makers looking for cold forming methods to reduce energy cost of heat treating process.					
Avdel		Ad illustrating 8 different fastening systems.				4 FA	AI 5/1/77 p. 30

FIGURE B-6. FASTENERS WORKSHEETS

WORK SHEET

SUPPLIER	AUTO MFG.	FASTENERS	MATERIALS	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
		Corrosion Resistance Coatings have improved - application technique: if finish builds up then dimensions thrown off. poor application of hydrogen embrittlement on fasteners makes them brittle. - materials: Size and materials may change but number of bolts needed per joint constant for given joint design.	Boron, high carbon spring steel, stainless steel, aluminum zinc plating			4 FA	AI 5/1/77 p. 20
		Alternatives Adhesives: permanently sealed components: in order to adhere to metal, surface must be properly prepared - drawing compound applied to all metal parts to prevent rust must be removed. Labor and time costs. Cure time: must be handled immediately. Cyano-acrylics in right direction. Welds and adhesives are permanent, nuts and bolts are not. Rivets: middle ground. Avdel Corp. estimates 100 million more blind rivets over previous years, have new design New design size cars may have fewer, if not smaller bolts (designed). New design tools: finite element analysis, transfer function analysis, computer modeling. Impact on bolt design: change will be on analysis of joints with side effect of whether more or less fasteners required. More emphasis on lighter materials rather than size. Bolt reduction (to bolt mfg.) is upgrading strength of bolt so smaller bolt can be used. Major way fasteners will help in wt. reduction will be through smaller high strength fasteners, rather than re-designing current styles.	Cyano-acrylics		Current wt. 100 lb. in car.		

FIGURE B-6. FASTENERS WORKSHEETS (Continued)

WORK SHEET

SUPPLIER	AUTO MFG.	FASTENERS	MATERIALS	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
		variables as amount of lubrication, friction, mating fit, etc. Torque figure only an estimate -- clamping force of 4000 lb. sought, torque control methods will bring you within 30% (± 1200 lb.). Problem greater with bolts tightened well over mark ⟶ snap. Torque figure adjusted so that outside upper limit isn't far enough above yield to snap fastener and lower limit adequate to hold fastener in place ⟶ put in bigger fastener or more fasteners than really need.				4 FA	AI 5/1/77 p. 20
		Clamp load of bolt can be more accurately set using tension control.					
		4 tension control systems being tested by Detroit: similar results, different approaches: 1) Ingersoll-Rand: change in torque rate which is proportional to degree of rotation of fastener. At yield pt., air motor shuts down and fastener tightened to yield. 2) SPS: Measuring the torque and rotation establishes a curve whose gradient is measured by SPS system. At yield, computer senses rate change and shuts off. 3) Atlas-Copco: "on demand" system uses torque and angle control to determine proper yield points. 4) Thor's: different from others. Pulses of air provides pt. to monitor torque, along with rotation. At yield, pulses stop.					
		All systems have some rundown mode which takes each of the fasteners down to a predetermined point.					
	GM	GM uses one system in a production facility ⟶ must be structural, not decorative.		$15,000 per system			

FIGURE B-6. FASTENERS WORKSHEETS (Continued)

FASTENERS

CTP - MCI 11/15/77 FA p. 4

WORK SHEET

SUPPLIER	AUTO MFG.	FASTENERS	MATERIALS	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
Dominion Road Machinery Co., Ltd. (Ontario)		Use heavy-duty retaining rings on hinge pins⟶ simplify design of linkage systems in Champion D-700 motor grader.		$3.24/unit (29¢ saved)		4 FA	AI 5/1/77 p. 46
	Ford	Hex head flange bolt redesigned: smaller mass but stronger (head flange able to withstand 1.4 x ultimate tensile strength of nominal bolt diameter in an oversize hole; minimum driving capacity of bolt = 2 x torsional strength). Not in production yet; in production, estimate 4500t of material saved each year. Tooling: same as conventional 2-blow headers multistation transfer equipment. Increased tool life and productivity.			less mass. 1 lb. steel = 44 bolts new M8-16. 33 old MB-16. 2000t saved each year in metal.	4 FA	AI 5/1/77 p. 47
		<u>Systems Approach to Mechanical Fastening</u> 2500 fasteners in car 3 divisions, all interconnected: 1) vehicle mfg. fastener group: joining parts car 2) fastener suppliers: supply parts 3) tool makers Qualities of fasteners 1) torque: measurement of turning force applied to object 2) tension: stretching of fastener that takes place when fastener is tightened⟶how fastener clamps joint together. Couldn't measure tension on assembly line so used torque as a measure of tightness. Now, electronic fastening tools use sophisticated electronics coupled with torque transducers to provide tension measurement. Using torque, can't assure more than 60% of clamping force that a fastener is capable of. Relation of force to torque is uncertain because of such				4 FA	AI 5/1/77 p. 20

FIGURE B-6. FASTENERS WORKSHEETS (Concluded)

MAJOR BODY PARTS WORKSHEET CTP - MCI 11/17/77 BP p. 1

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Frame			Fork-type frame provides more controlled deformation of the front end to improve crashworthiness.		Audi	'78 Audi 5000	Reduced weight			4 8P	WAR 8/1/77 p. 245
			Experimental diesel car also has fork-type frame which would protect occupants from frontal collisions up to 40 mph.	VW	VW						
Frame			Downsized to wheelbase 108 inch but keep full-frame construction of car 114 inch wheelbase and larger. See attached list for U.S. cars by Body/Frame type.		GM	'78 Intermediates (A-body)	Cars 550-980 lb. less than '77 models			4 8P	WAR 7/18/77 p. 229
Body panels	Aluminum alloy 6% copper 0.5% zirconium	Unique process: air pressure forms alloy shapes on single die.	Process used mostly on complex shapes that would otherwise require fabricated assemblies from a number of different parts. Most suitable for medium production runs of 100 to 10,000 pieces.	Tube Instruments	Aston Martin	Loganda		Low tooling cost. $425 per sq. ft. of plan dimensions (1/12 cost conventional stamping die). High material costs.		4 8P	AE 8/77 p. 18

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS

MAJOR BODY PARTS WORKSHEET CTP - MCI 11/17/77 BP p. 2

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Possible applications: cont. Headlamp doors Grille surrounds Structural seat shells										4 BP	AN 5/30/77 p. 8
Floor pan Outer Wheel House	HSLA Steel	Galvanized	Materials outlook for 1977: total use on cars up. Steel New processes developed and existing ones expanded by steel industry: HSLA steel, hot-dip galvanization; electrogalvination, one-side galvinazation. Aluminum Most increases are in bumpers although work on hoods and deck lids being done.		GM	'77 reduced standard size cars				4 BP	WAR 1/3/77 p. 4
						'77 models	Forecast per car 100 lb. car				
						'76 models	87 lb. car				
						'75 models	80 lb. car				
						'74 models	75 lbs.				
Hoods	Aluminum			Reynolds	GM	'78 Caddy		higher cost			
Hoods	Aluminum			Alcoa	GM	'77 Olds 88					
			See list attached for selected '77 Chrysler Corp. models.								
Frame	HSLA steel 980XK	Reduced welding operations	HSLA substituted for plain carbon steel in similar way as '77 AMC Gremlin and Hornet.		Ford	'78 Fairmont/ Zephyr	3.44 lb/ car in sill area	Reduced: fewer parts, less tooling investment.		4 BP	AMM/MN 6/27/77 p. 11

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Continued)

MAJOR BODY PARTS WORKSHEET CTP - MCI 11/17/77 BP p. 3

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Door cont.		Output increase six times current rate.						(about 67% less)		4 8P	AI 3/15/77 p. 36
Door	(SMC) Plastic/ Fiberglass reinforced		Study included analysis of design, material thickness, construction and assembly techniques. 13% increase in manpower 6x output rate.	Owens-Corning			Steel = 68 lbs. fiberglass/ plastic = 37 lb.	Fuel energy savings in production. $25 per door for 250,000 today. $17 SMC. $18.50 steel. 1.2 million. tooling 80¢ SMC $3.00 steel. Plant and equipment outlay $22 million .		4 8P	AN 5/30/77 p. 8
Possible applications: Instrument panels Sideview Mirrors Car door handles Wheel covers	ABS (acrylonitrile butadienestyrene) family of 15 plastics		Observations and predictions made by Jim Goggin; General Manager of automotive plastics line on use of ABS. Auto industry consumes 20-25% U.S. ABS production. 1980-81 use ABS 26-28 lbs./ vehicle as opposed to 21-22 lbs. originally forecast. Not currently used in place of sheet metal because no plastic can withstand 350 degrees needed for heat treating most paints.	Borg-Warner Chemicals	AMC	'77 Models Pacer	16-21 lbs. ABS 38 lbs. ABS in 70 parts.			4 BP	AN 5/30/77 p. 8

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Continued)

MAJOR BODY PARTS WORKSHEET CTP - MCI 11/17/77 BP p. 4

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Hood cont.			Assembly system employs combination of resistance spot welding adhesive, spot welding, adhesive, spot deposition, hemming, metal inert gas, spot welding to assemble the inner and outer panels, and the cowl assemblies as well.	Resistance Welder Corp. (assembly system)						4 BP	AMM/MN 4/25/77 p. 14
	Aluminum Alloy 6009				Ford	'78 heavy duty truck cabs					
Rear end moldings	Plastic (glass fiber-reinforced sheet molding compounds)		Budd will supply plastic rear end moldings; including decks.	Budd Co.	GM	'78 Chevy Corvette				4 BP	AMM/MN 5/9/77 p. 19
Front skirts			Budd will supply complete front skirts, including grille opening, headlamp housings, and wheel housings.		Ford	'78 heavy duty trucks				4 BP	AMM/MN 5/9/77 p. 19
Door	(SMC) plastic/ fiberglass reinforced compound inner and outer panels with steel side impact beams	Shuttle technique developed which uses press only for compression of plastic mold with curing done outside.	Study by Owens-Corning concluded 1.2 million plastic doors could be technically and economically produced annually. Study based on current production techniques as well as processing improvements which have recently emerged from the development stage - need improvements to get advantages.	Owens-Corning			43% less than steel door. 29 lb. less per door (for car 2700-3700 lb.)	Lower production cost but higher material cost. $18.50 steel, $17.00 plastic, for 1.2 million. Lower capital outlay		4 BP	AI 3/15/77 p. 36

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Continued)

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Fender Liners	Plastic: ex-reinforced poly-propylene copolymer	Injection molding machines	Plastic fender liners replace steel and have benefits in terms of weight and corrosion-resistance.	GM manufacturer fenders Material and chemical suppliers: Thermofil, Inc; Oart Ind.;	GM	'78 downsized intermediate cars. Chevy Malibu, Monte Carlo. Buick Century, Regal	About 10 lbs/car saved. Fenders weigh about 7 lb. ea.			4 BP	AMM/MN 8/1/77 p. 5
	Steel		Continue with steel liners with superior strength, flutter-resistance, durability. Expect at least 2-million plastic units molded. Steel manufacturers disappointed.	Hercules, Inc.; Owens-Corning	GM	Pontiac					
	Thermo-plastic	Stamped		Ford	Ford	'78 light duty trucks series "F"					
Hood	Aluminum		1st industry use	Reynolds	Ford	Lincoln Versailles	Save 13 lb. from steel.			4 BP	AMM/MN 4/11/77 p. 24
Hood	Aluminum Alloy 6009 or 6010 or 5182-SSF	Assembly system employ combination of tasks.	All aluminum hood to be installed on Buick Regals loaded with options and emission control devices. These are optional aluminum hoods with steel hoods as standard on Regals. These alloys are lighter and more formable than usual alloys 2036 and 5182.	Reynolds (sole supplier alloy 5182-SSF) Alcoa (6009 or 6010)	GM	'78 Buick Regals				4 BP	AMM/MN 4/25/77 p. 14

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Continued)

MAJOR BODY PARTS WORKSHEET CTP - NCI 11/17/77 BP p. 6

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Body Panels	Panels made from glass fiber-reinforced polyester	Are coated with primer prior to assembly on car.	Panels contain hood extension, grille surrounds and fender extensions.							4 BP	AMM/MN 7/25/77 p. 1
			Working on advanced primers that can be applied to plastic parts while they're still in the molds of the forming machines.	General Tire and Rubber							
			Appearance problems and finishing costs have been of the biggest drawbacks up to now in using plastics in large, visible areas.								
Deck Lids	Aluminum		1st U.S. auto industry use.		GM	'78 Chevy Monte Carlo '78 Buick Regal					
Rear Deck Lids	Aluminum Alloy 2036 Outer Panel		Cars with extra options, including California cars.		GM	'78 Chevy Monte Carlo '78 Buick Regal				4 BP	AMM/MN 6/20/77 p. 15
	Aluminum Alloy 5182 Inner Panel	Stamped								4 BP	AMM/MN 6/20/77 p. 15

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Continued)

MAJOR BODY PARTS WORKSHEET CTP - MCI 11/17/77 8P p. 7

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MOOEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEOIA REF. BOOK NO.	REFERENCE
	Aluminum		Reduce drag by 9% with wheels, hood and boot lid plus spoilers front and rear.		Mercedes 8enz	450 SLC Coupe				4 BP	WAR 10/3/77 p. 317
Door	Fiberglass-reinforced-plastic sheet molding compound (SMC)			Owens-Corning			40% less on doors	Cut assembly costs		4 BP	WAW 10/77
Door Beams	HSLA Impact beams	Stamped one-piece units	Replaces roll-formed HSLA steel beams which require reasonable uniformity in material thickness and shape for consistant spring-back qualities and high productivity. Will be used in both front and rear beams.	GM (Fisher Body)	GM	'78 Intermediate Chevy Malibu, Pontiac LeMans, Olds Cutlass, Buick Century.	Lighter	Less Costly		4 BP	AMM/MN 8/22/77 p. 12
Door Beams	Steel		Steel side door impact beams.		Ford	'78 Fairmont/ Zephyr				4 BP	AMM/MN 8/22/77 p. 12
Body Panels	Polyurethane primer for coating plastic parts	Compression molding machines make one piece panels	Full-length front header panels will be first major application of polyurethane primer that's said to eliminate, or cover up imperfections, sink marks or 'valleys' on the surface of plastic panels.	Sherwin-Williams Co. (primer)	GM	'78 Chevy Intermediate size.	Malibu 550-972 lbs. lighter than '77 yr.			4 8P	AMM/MN 7/25/77 p. 1
						Malibu	7 lb. less than metal assemblies				
						Monte Carlo	12 lbs. less than metal.				

FIGURE B-7. MAJOR BODY PARTS WORKSHEETS (Concluded)

MISCELLANEOUS COMPONENTS WORKSHEET CTP - MCI 11/15/77 MI page 1

COMPONENTS	AUTO MFG.	MODEL		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
			3) production quality: a) materials used. b) improper manual assembly adjustment shift to automated quality improved c) in future, computer in car could monitor more complex bearings and warn of trouble. Types: needle, roller, ball — all possible with new design. SKF manufacturer design combines function of hubs and bearing together.						4 MI	AI 7/1/77 p. 22
Grilles	GM	'77 Chevy Caprice '79 Chevy Chevette Camaro	1st installation to chrome-coat rigid plastic lower grilles. 2nd installation to chrome coat rigid ABS plastic grilles. In future, chrome-coat flexible lower grilles.	Chrome-sputtering system. (Mfg.--Varian).	Chrome-coated plastic				4 MI	AMM/MN 10/24/77 p. 22

FIGURE B-8. MISCELLANEOUS COMPONENTS WORKSHEETS

COMPONENTS	AUTO MFG.	MODEL		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REOUCTION	MEDIA REF. BOOK NO.	REFERENCES
			Sealed - prepacked with grease. Sealing system developed by Ford,							
Sealed bearings			New engine - drive-train layout (FWD) promoted redesign of bearings from scratch so current tooling not factor. Expected lifetime 100,000 miles.		Plastics	Higher initial cost, same over lifetime.		Lighter wt. materials	4 MI	AI 7/1/77 p. 22
			Factors in change: Abandonment regular service interval, FWD Materials: 1) lighter weight materials (plastic, nylon, delvin) being used in some parts. 2) silicon nitride rolling element.		Silicon nitride	Cost now $100 ea.				
			3) powdered metal - used in heavy duty trucks (Federal Mogul).			Economy on large parts				
			Factors in life bearing: 1) effective seal most important: function of temp. and operating conditions. 2) lubricant: factory sealed lubricant must be better than one which is expected to be changed every 2 years.		Synthetic rubber seals.					

FIGURE B-8. MISCELLANEOUS COMPONENTS WORKSHEETS (Continued)

MISCELLANEOUS COMPONENTS WORKSHEET

COMPONENTS	AUTO MFG.	MODEL		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
Grilles	GM	'77 Chevy Caprice '79 Chevy Chevette	Alternative to electroplating. Caprice only production application - lower grilles of ABS plastic placed in vacuum coating chamber and covered by chromium atoms. Testing done for upper grille application.	Vacuum metalizing or sputtering.	Chrome sputtered ABS plastic	Process more efficient and lower cost. Savings in energy and chrome.		Reduces weight.	4 MI	AMM/MN 8/29/77 p. 2
Window brackets	Ford	'77 LTD II '77 Cougar XR7	Replaced galvanized steel window brackets with plastic. Brackets used to support and guide glass in doors whenever it's raised or lowered.		Plastic			1¼ lbs, per bracket.	4 MI	AMM/MN 1/31/77 p. 7
Radiator			New design matches simplicity and cleanliness of all - mechanical assembly with copper's advantages in corrosion resistance and thermal/aerodynamic performance capabilities. It also permits standardization of parts. Developed by Marston Radiators (England).	Automated production line and one step soldering	Copper-based	Production cost 15% less. Indirect savings in heating fuel and water. 35% labor less.		80% solder weight. 50% brass blank weight.	4 MI	AE 7/77 p. 23
Sealed bearings (Timken Mfg.)	Ford	Fiesta	Sealed tapered roller bearings mfg. by Timken for front wheel drive. Set right method - use close tolerance control in production: result is bearing assembly in which inner braces are butted together so no bearing setting is needed.	Set right method.					4 MI	AN 7/11/77 p. 18

FIGURE B-8. MISCELLANEOUS COMPONENTS WORKSHEETS (Concluded)

POWER ACCESSORIES WORKSHEET CTP - MCI 11/17/77 PA page 1

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Water Pump	Aluminum Alloy 309	Die Cast	Replace current cast iron water pumps on at least some of Ford's 302 and 351 cubic-inch V-8s. Since more than 60% of Ford's engines are V-8, could indicate substantial new market for aluminum suppliers. There are more than one million 302 and 351 engines produced each year.	Kingsbury Machine Tool Co.	Ford	'79 MY cars with V-8 engines loaded with options, including reduced standard size models and Ford LTD Mercury Marquis.	Aluminum pump = 5½ lbs. Cast iron pumps = 13½ lbs. Total weight reduction pump and intake manifold = 20 lbs.			4 PA	AMM/MN 4/25/77 p. 13

FIGURE B-9. POWER ACCESSORIES WORKSHEETS

POWER ACCESSORIES WORKSHEET CTP - MCI 11/17/77 PA page 2

COMPONENT	MATERIAL	TOOLING	NOTES	SUPPLIER	AUTO MFG.	MODEL	WEIGHT REDUCTION	COST	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Rotary A/C Compressor			Draws power directly from engine in 2 ways: 1) directly as the engine crankshaft drives the compressor drive shaft via V-belts and pulleys. 2) indirectly as electical energy from the battery which operates the electromagnetic clutch and other electrical control devices. New rotary compressor, smaller than conventional piston compressors, minimizes noise and vibration; reduces weight, can cool large and small vehicles. 4 different pulley and clutch designs available to be compatible with various drive configurations.	York Automotive Div. Borg-Warner			Wt. reduction.	$30 million over next 5 years on plant.		4 PA	AI 7/15/77 p. 38
Rotary A/C Compressor			Compact rotary design is said to provide greater mounting flexibility, minimum noise and vibration; and use fewer parts. Utilizes rotating vanes to compress refrigerant gas while conventional units operate with reciprocating pistons.	York Automotive Div. Borg-Warner			Weighs less than 15 lb. (plus 6½ lb. for oil and clutch).			4 PA	AE 2/77 p. 14
Alternator	Steel	Stamped		U.S.Steel			10% less than cast aluminum housing			4 PA	AE 10/77 p. 5

FIGURE B-9. POWER ACCESSORIES WORKSHEETS (Concluded)

ROOFS

WORKSHEET

ROOF MFG.	AUTO MFG.	MODEL		MATERIAL	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
	GM	Interim A Body Pontiac	Skyvent is installed by Fisher, parts bought from ASC.				4 RO	AI 3/15/77 p. 18
	Chrysler	LeBaron, Dodge Diplomat	Power sun roofs in either metal or tinted glass.					
American Hatch Corp. made by Excel Industries	GM	Chevy Monte Carlo and Camaro, Pontiac Grand Prix & Firebird, Buick Century, Regal, Olds Cutlass Supreme,	40% installations made by GM. glass hatches: aluminum "surround" around the glass which reportedly eliminates leaking and makes a stronger hatch panel. The glass is bonded to the aluminum with a patented liquid adhesive which then passes through a drying oven for maximum adhesion. Because of heat, use monolithic tempered glass supplied by PPG Industries. Claims of superiority of approach questioned. Hardware attached to metal surround.				4 RO	AI 3/15/77 p. 18
	Chrysler	Chrysler Cordoba						
Specialty Car Div. (Hurst)	GM Ford Chrysler	Grand Prix, Cutlass Supreme, Century, Firebird, Trans Am, Camaro, LeMans, T-Bird, LTD II, Cougar	Process similar to ASC and C&C Inc.					
	Ford	Mustang II, Pinto, Bobcat, T-Bird, Granada, Monarch, Lincoln	Flip up glass moon roofs Power moon roofs Fixed-glass moonroof } are installed by Ford					

FIGURE B-10. ROOFS WORKSHEETS

ROOF MFG.	AUTO MFG.	MODEL		MATERIAL	COST	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
	Chrysler	'78 Ply. Volare '78 Dodge Charger S.E.	T-roof: open-air hatchroofs and tinted glass sunroofs. 1st time original equipment option.	Less steel			4 RO	AMM/MN 8/22/77 p. 5
	Ford	'78 Ford Mustang						
			Special roofs - removable glass hatch roof, sliding metal sunroofs, glass moonroofs, flip tops and new side and window treatments.	Steel "spine" running back from middle of header to rear of roof. Later covered with an aluminum stamping.	$150 million per yr. for ½ million cars. $600 - $1200 each.	Adds 50 lbs.	4 RO	AI 3/15/77 p. 18
American Sunroof Co.	GM	Cadillac Eldorado Seville	Produced and installed by customizers (mostly) - 15-20,000/165,000 jobs installed by GM.					
	Ford	'77½ Ford Mustang						
Cars and Concepts, Inc.	GM Chrysler	Plymouth Aspens, Dodge Volares, Chrysler Cordobas, Dodge Charger S.E. kits--Chevy Monte Carlo & Camaro, Pontiac Grand Prix, Buick Century, Olds Cutlass Supreme	ASC, C&C Inc. SCO use laminated glass (often supplied by Libby-Owens-Ford). Help provide "smoke" effect on glass roofs to reduce most of light and heat transmission into car. Hardware attached through holes in glass. Cars and Concepts Inc. installs some. It also produces hatch roof kits which are installed by 72 franchised installers around country.					

FIGURE B-10. ROOFS WORKSHEETS (Concluded)

SEATS WORKSHEET

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SEATS

SUPPLIER	AUTO MFG.		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
	GM	Chevy Corvette in '78 would be 1st all plastic seats. Eliminate considerable amount of metal - fairly complex steel spring and frame, metal hinges, hog rings, brackets, wire, bushings and fasteners	Thermoplastic stamping or compression molded seat.	Glass fiber reinforced polypropylene or glass fiber reinforced polyester				4 SE	AMM/MN 1/3/77 p. 14
Flex-o-Lators	GM	Corvette. Delay in introduction until Feb. or March 1978 - need to redesign only metal part. Need to simplify steel wire retainer.		Foamed urethane cushions				4 SE	AMM/MN 6/27/77 p. 10

FIGURE B-11. SEATS WORKSHEETS

SUSPENSION AND STEERING WORKSHEET

SUPPLIER	AUTO MFG.	MODEL		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
			and features a rubber doughnut for noise reduction and a built-in wear indicator. A front stabilizer bar is standard and attaches to the body through graphite impregnated polyethylene sleeves and to the lower A-arms by rubber-mounted links.		rod guide. Hard chrome plated piston rod.					
Owens-Corning Fiberglass Corp.			Passenger car springs. 70% wt = glass. Other possible materials are kevlar or graphite fiber.		Glass reinforced plastic.			21-23 lbs. less (plastic = 7.9 lbs. steel = 30 lbs.)	4 SS	AN 8/15/77 p. 16
	Ford	Fairmont Zephyr	MacPherson strut front suspension has separate coil spring from strut - compact installation. Wear is from 50,000 mi.+ - - Ford calculating 1st owner will never replace front shocks.			high replacement cost.			4 SS	WAR 9/5/77 p. 284
Kostal			Steering column switch assembly. Multifunctional switch assembly - starter, turn signals, headlights, washer/wipers, seat belt, open door safety alarm. Properties "Delrin": dimentional stability, high strength, low-wear, low friction (not need lubrication), good electrical insulation properties.	Simpler: no post-machine needed as with metal parts.	"Oelrin" ocetal homopolymer resin.				4 SS	Dupont Auto Plastic News

FIGURE B-12. SUSPENSION AND STEERING WORKSHEETS

SUSPENSION AND STEERING WORKSHEET

SUPPLIER	AUTO MFG.	MODEL		TOOLING	MATERIAL	COST	FUEL ECONOMY	WEIGHT REDUCTION	MEDIA REF. BOOK NO.	REFERENCES
Goodyear			Inflatable air springs to be used for suspension. Handle wide load-range just by changing inflation pressure -- easy with electric air compressors and electronic leveling controls. Especially important on smaller, lighter cars. Air springs take less space than conventional steel coil.		Rubber Aluminum				4 SS	WAW 10/77 p. 115
Monroe Auto Equip. Co.			Electric eye sensor built into shock absorber triggers an electric air compressor which fills or exhausts shocks (with changes in loads) to keep a vehicle at its predetermined level. Sensing device replaces former compressor-reservoir system used to fill shock absorbers. Diode life is several hundred thousand hours so device life is greater than car life.			Installation cost less. No separate value to mount nor adjustments.			4 SS	AN 10/10/77 p. 49
	Ford	Fairmont-Zephyr	MacPherson like front suspension. Coil springs mounted between lower A-arms and #2 crossbar, rather than concentrically about struts themselves so easier to replace. A single ball joint, of loaded design, is on each side		Polymer-coated sintered iron piston. Bronze teflon-impregnated				4 SS	AE 10/77 p. 41

FIGURE B-12. SUSPENSION AND STEERING WORKSHEETS (Concluded)

TIRES

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WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF.' BOOK NO.	REFERENCE
Radial			Wt. ranges on 23 tires sizes 165 SR-13	Steel Rayon Nylon Polyester		I5.5-I9.0 lbs./tire		4 TI	Road & Track I0/77 p. 78
Radial		IRI	Tiny Producer - 600 radial auto tires produced daily (I/I250 produced daily) 50,000 mi. warranty. Compete head on with Michelin	"All Steel" steel belted tread and sidewalls	$80 retail			4 TI	WSJ 8/I0/77 p. I

FIGURE B-13. TIRES WORKSHEETS

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Radial			Radial trend -- increased use over next 5 years. Opposing pressures at opposite end market: counter escalating costs on its smaller cars (cheaper tires) vs give larger cars all mpg benefits possible (radials). so radials won't replace bias and belted bias completely.					4 TI	WAR 10/10/77 p. 323
All-Weather Radial		Goodyear	Tiempo. Expect Tiempo to account for ½ GY radial winter tire sales this year. Can be mixed with bias or belted and bias but should mount on rear wheels and not on same axle with tires of another construction, including radials.	2 plies polyester cord topped by 2 belts steel				4 TI	AN 10/3/77 p. 19
All-Weather Radial		Goodyear	Tiempo					4 TI	WAW 10/77 p. 94
		Uniroyal	Royal Master - shoulder tread has wrap-around design and steel-belted radials' unusual profile.						
Radial		Michelin	Michelin expanding output 25% next year at Greenville (S.C.) plant, build new radial plant at Dothan (Ala.), expand rubber products facility at Anderson (S.C.)					4 TI	WAW 10/77 p. 95
Conventional		Goodyear	Phasing out production in L.A.; lays off 650 workers in Akron -- inventory build-up complete.						

FIGURE B-13. TIRES WORKSHEETS (Continued)

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WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Radials for electric cars		Fire-stone	Electric cars will probably use radial tires: reduced rolling resistance key factor (rolling resistance radial 30% less conventional bias-ply tire). Steel wheel on steel rail least rolling resistance but not practical. Reducing rolling resistance by raising air pressure being studied. Investigating material properties of various tire cords, tire construction features, tire shapes, use of different rubber components in beads and sidewalls.					4 TI	AI 9/15/77 p. 10
All Weather Radial		Good-year	All-weather radial. Steel-belted. Traction better than polyester - steel radial but less than winter radial. Tire tread made from compounds especially formulated for studless winter tire - softer than rubber so mileage lower, but exceed fuel economy, highspeed handling, dry pavement traction of traditional tire. Price 15% less OE Custom Polysteel, 17½% less studless winter tire.		\$39 (BR 78-13) to \$81.30 (LR-78)		Increased	4 TI	WSJ 9/13/77 p. 19
Elliptic		Good-year	Elliptic tire Goodyear Inflate up to 50% higher so reduce rolling resistance. Larger wheel needed. Factors affecting rolling resistance: tire pressure, basic construction type, design of tread, depth of tread, composition of rubber used, type and placement of tire cord and belts.				Increase MPG 3-10%	4 TI	WSJ 7/27/77 p. 6
Elliptic		Good-year	Rolling resistance reduced 34%. Fuel Economy 7.5% better than steel belted radials: 25 more miles/tankful.				Increase 7.5%	4 TI	WSJ 8/2/77 p. 11

FIGURE B-13. TIRES WORKSHEETS (continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. ' BOOK NO.	REFERENCE
Radial cont.			GM & Ford: 80-90% radials. Chrysler 40-60% --soon 100%. Carcass fibers differ: nylon cord rolling resistance may be less than polyester; steel, glass, natural rubber better than synthetic rubber for hysteresis. Steel even better rayon.					4 TI	AI 5/15/77 p. 27
Compact Spare			GM 1978 downsize intermediates and some Ford compacts -- small high pressured spare tire casings require about ½ space & 20 lbs. lighter. Could ride at 60 mph.						
Light Wt. Spare		Good-year	Goodyear foldable spare tire - 25% of 1977 full size spare. Fullsize light weight spare						
		Fire-stone Uniroyal	Tire w/fiberglass stabilizer or insert inside casing -- 50 mi. at 50 mph. Problem w/friction and heat build-up and skidding. Goodyear insert = ½ wt. tire. Save only 7½ lb. w/o spare, jack, wheel.						
Non flat Spare		Good-rich	Conventional tire w/beefed-up sidewalls.						
		Uniroyal	Highway safety has been improved by longitudinal grooving of pavement. Disturbances in car ride can be minimized by coordinating tire groove spacing in tread and pavement groove spacing by standardization.					4 TI	AE 10/77 p. 50

FIGURE B-13. TIRES WORKSHEETS (Continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Compact Spare cont.	GM	5 OEM	Dimensions: 2 in. (5 cm) narrower diameter than conventional tire. 1 in. (25 mm) larger wheel, no wheel cover or hub cap (but circumference 4" less) Trunk Space: saves 1.3 cu. ft. (0.04 cu m.) Life expectancy compact tire: temporary use only--could be driven over 100 mi. (161 km) Total life - "couple of thousand miles" Could last life of car since expected to be driven 50 mi. (80 km) every 18 mo. Life expectancy regular tires reduced 20% --only 4 not 5 regular tires. Slight list on car.		Price spare less but buy more regular tires	Wt. car down 11 lbs.(5 kg). Compact spare 30% less reg. tire. Compact spare 15-20% less folding spare w/can inflating gas.	more MPG if car smaller	4 TI	AI 5/15/77 p. 14
Non-Flat Spare	GM	Goodyear Fire-stone Goodrich Uniroyal	Run flat tire -- friction reducing lubricant in tube used if tire runs flat. Once a car achieves steady state operation on the highway, 15-25% fuel consumed by tires. Make 10% reduction of the power that the tire consumes, then fuel economy of cars improve 2%. (Could be worth $200 million to car mfg.) Reduce "hysteresis" - material's tendency to lose its resiliency from repeated flexing - rolling resistance of casing also reduced.				10% reduction of power used by tires improves fuel economy 2%.	4 TI	AI 5/15/77 p. 27
Radial			Parts of tire - carcass, bead & tread. Bead can't be changed, tread (lose ½ energy) is biggest weight contributor. 1977 GM B-cars F, G, H tires 2-2½ lbs. lighter. Uniroyal - redesigning radials' cavities; treads, materials, bead configuration 9-12 mo. next generation radials. Radials reduce rolling resistance. 20% power reduction in 1st generation radial; 10% in 2nd generation.			2-2½ lb. F, G, H tires			

FIGURE B-13. TIRES WORKSHEETS (Continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Truck Radials	GMC		1977 installing 25% on class 7 & 8 trucks; 6.7%-29.5% on specific models					4 TI	WAR 8/8/77 p. 251
	Mack Trucks		1977 installing 35-37% highway type trucks 1976 installed 30%						
	International Harvestor		1977 installing 25% on trucks with size 10:20 or larger tires 1976 installed 5% projection = 50% radial usage industry-wide by 1980 vs previous forecast of 35% by 1985.						
Non flat Spare		Rocker (formerly Rocker Research Corp) (Redmond Wash.)	Developed tire sealant and allied system that would reinflate tire: -- eliminate spare and jack. Sealant remains sticky for years, does not "travel" inside the tire and remains stable and ductile at temp. up to 270^{0}F. Production available -- could sell in 6 mo.		Cost Advantageous	4" shorter Several hundred lbs. lighter	Higher MPG	4 TI	AN 7/11/77 p. 16
		Yokohama Rubber Co. (Japan)	Currently using system under license and marketing tires						
		Uniroyal	1st U.S. tire company to install Rocker System						
Compact Spare	GM	5 OEM	Compact Spare High Pressure: 60 psi (414 mpg) air and not flatten out so only 1.25 in. (32 mm) less rolling radium when installed. Dimensions: 4 in. (10 cm) smaller diameter than conventional tire		cost of spare less but buy more regular tires	Wt. car down 11 lb. (5 kg) Compact spare 30% less regular tire. 15-20% less folding spare w/can inflating gas.	More MPG car smaller	4 TI	AI 5/15/77 p. 14

FIGURE B-13. TIRES WORKSHEETS (Continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Truck Radials			Heavy-duty trucks using more radials -- increased tread life, improved fuel economy, higher % of recappable casings and less noise	Radials	Lower operating costs but higher initial costs		Improved MPG	4 TI	WAR 3/8/77 p. 251
		Goodyear	1977 (projected) radials = 14.4% total market H.D. over-the-road tire trucks & OE & replacement						
			1976 Radials = 12.4% total market H.D. over-the-road tire trucks & OE & replacement						
			1975 Radials = 7.9% total market H.D. over-the-road tire trucks & OE & replacement						
			1970 Radials = 2.5% total market H.D. over-the-road tire trucks & OE & replacement						
			1980 (projected) Radials = 40.2% total market H.D. over-the-road tire trucks & OE & replacement						
		Firestone	1977 (projected) Radials = 16 % total market H.D. over-the-road tire trucks & OE & replacement						
			1973 Radials = 5-6% total market H.D. over-the-road tire trucks & OE & replacement						
	Ford		1977 installing radials on >20% class 7 and 8 trucks.						
			1976 Radials = 20% class 7 & 8						
			1971-75 Radials = 4% class 7 & 8						

FIGURE B-13. TIRES WORKSHEETS (Continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Compact Spare		Uniroyal	Hideaway spare tire compact. Temporary use only and stored fully inflated. Available on '78 cars.			smaller than conventional tire		4 TI	AN 7/18/77 p. 39
Not flat Spare		Goodrich	Non-flat tire. Not in commercial production yet -- undergoing extensive testing to certify performance of internal structure.	Radial				4 TI	WAR 3/7/77 p. 76
			Making tire last longer (than current 35000-40000 mi.) is neither economic sense nor customer (car maker & motorist) requirement, managing director of Dunlop Holdings Ltd. in England told National Tire Distributors Assoc.					4 TI	WAR 8/8/77 p. 251
Non flat Spare	Leyland	Dunlop Denovo	Leyland Mini 1275 for '78 World's 1st car to incorporate Dunlop Denovo run-flat safety tires at no extra cost.		No extra			4 TI	WAR 8/15/77 p. 261
Elliptical	Ford	Goodyear	Elliptical tire. Increase tire inflation by 10 lbs. -- cut road resistance, increase mileage of tire. Special wheel diameter 1" larger but sidewalls lower so overall diameter tire and wheel same.		tires same wheel increase		New=18.86 S.8 radial= 17.52 8ias Ply= 16.22 MPG	4 TI	DFP 7/27/77 p. 9D
Radials		Goodyear Dupont	Arimid belted radials replacing steel belted. 8etter riding and same durability as steel belted radials.	Fiber-glass belted radials	Cheaper			4 TI	MT 4/77 p. 18

FIGURE B-13. TIRES WORKSHEETS (Continued)

WORKSHEET

TIRE DESIGN	AUTO MFG.	TIRE MFG.	TIRES	MATERIALS	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCE
Pneumatic			Unitized pneumatic tire assembly does not have metal wheel. Unitized elastomeric structure with chemically bonded integral metal hub, sidewall inflation valve, and simulated spoke wheel design. Not need tire-wheel mounting nor metal wire bead nor multiple layers fabric or wire cord piles of conventional pneumatics.			Significant reduction (lbs. not given)		4 TI	AI 9/1/77 p. 54
Elliptical		Goodyear	Elliptical tire. Sidewall with built-in curve increases inflation pressure 50%, reduces rolling resistance. Requires special rim. Aim at OEM.	Steel-belted radial	"Not prohibitive" in volume production		Boosts 6%	4 TI	WAW 8/77 p. 9
Compact Spare	GM	Firestone General Uniroyal	Compact spare tire for redesigned '78 intermediate cars Life of tire 1000-3000 miles. Space required = ½ conventional spare tire and wheel.	4-ply bias construction		11-14 lbs.		4 TI	WAR 8/29/77 p. 276
Elliptical	Ford	Goodyear	Elliptical tire: sidewalls shorter and more curvilinear so 50% increase in air pressure. specially designed wheel: diameter 1" longer than conventional and flange=.04".	Same as current Radials	$25-35 to consumers	Same as conventional tire and wheel	4-10% increase MPG	4 TI	WAR 8/1/77 p. 245
Elliptical		Goodyear	Elliptical tire. Since wheel special, auto maker would have single source supply for tire and special wheel. This may also be hangup for DOT (who hasn't approved yet.) Could be 9 mo. until approval. Handling & smoothness of ride same. Once approved, could be in production in 3 months.	Polyester cord body w/steel belts			4-10% increase MPG (7.5% at demonstration)	4 TI	AN 8/1/77 p. 6

FIGURE B-13. TIRES WORKSHEETS (Concluded)

WHEELS

WORK SHEET

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Aluminum	Fabricated Conventional stamping presses, dies and roll forming machines can be used.	1979 Downsized standard models - body size R Number of cars or proportion cars with alum. wheels not known.	Kelsey-Hayes Company	Chrysler	Lower Production cost than forged or cast.	Up to 10 lbs. per wheel.		4 WH	WAW 10/77 p. 88

FIGURE B-14. WHEELS WORKSHEETS

WHEELS

WORK SHEET

CTP - MCI 11/3/77

WH page 2

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Stainless Steel pressings riveted to central flange of alum. rim.	Fabricated	Light weight and strength motorcycle wheel case balancing wheel.		Honda	Lower assembly costs	Light weight		4 WH	AE 4/77 p. 18
Al-Mg. 5454	Fabricated Conventional equipment Can be decorative	Fabrication process: strip of aluminum sheet formed into hoop and joined by electron-beam or resistance-buff welding. Next, hoop is flared and rolled into its final rim shape; new alum-forming technology allows thickness to be controlled during critical operation. Last, stamped spider is MIG-welded to rim.	Kelsey-Hayes w/Reynolds Alcoa			Reduce 50 lbs.		4 WH	AE 5/77 p. 15
Aluminum	Forged	9.2% extra coil styled wheels in 1977 made of aluminum. Offered on 29 of industry's '77 cars soon available on some light duty trucks and vans.	Alcoa	Ford GM Chrysler				4 WH	WAR 6/6/77 Special Report
Aluminum	Fabricated: Use stamping tools	Technology available and simpler. (Eliminates most of machine operations.)			Lower than forged or cast.			4 WH	WAR 6/6/77 Special Report
	Cast	Easier to make complex designed, but need to X-ray each wheel. May enter after-market business for both cars and light trucks.			Lower than forged.			4 WH	WAR 6/6/77 Special Report
Styled Steel & Steel-Polycast (urethane Insert)		Largest supplier styled wheels. No intention entering aluminum wheel business or after business (from which it withdrew 2 years ago.)	Motor Wheel Co.		Huge Initial Investment forged or cast			4 WH	WAR 6/6/77 Special Report

FIGURE B-14. WHEELS WORKSHEETS (Continued)

MATERIALS	TOOLING PROCESS	WHEELS	WHEEL MFG.	AUTO MFG.	COST	WEIGHT REDUCTION	FUEL ECONOMY	MEDIA REF. BOOK NO.	REFERENCES
Aluminum	Fabricated	Production target date 7/1/78 for '79 model passenger cars. 400,000-800,000 on 1979 passenger cars.	Kelsey-Hayes					4 WH	WAR 4/25/77 p. 131 WAW 5/77 p30
Aluminum		Wheel designs weigh ½ steel counterparts.				40-60 lb/car (18-27 kg)		4 WH	AI 4/1/77 p. 119
Al-Mg alloy 5454	Fabricated	Production similar to steel wheels. Prototype quantities available for testing 2nd quarter. Welding characteristics, fatigue strength corrosion resistant, forming ability, complete with conventional wheels.	Alcoa			Direct: 1 lb. Al= 1½ lb. st. Indirect: 3/4 lb. Al.= 2¼ lb. less car weight.		4 WH	AI 4/1/77 p. 120
		Chance for use on 1978 models look excellent.	Motor Wheel Kelsey-Hayes Reynolds					4 WH	AI 4/1/77 p. 120
Aluminum	Fabricated	Introduction on some 1979 U.S. cars - at least 400,000 sales.	Kelsey-Hayes Reynolds Metal Co.		up to $30 more for alum. but savings on smaller, simpler wheel cover.	Up to 50 lbs. per car. Full size cars Al wheels 10-12 lb. steel 20-25 lb. fabricated (50% lighter than st.)		4 WH	AI 5/15/77 p. 32
Aluminum	Fabricated (Alcoa)	With new aluminum alloys and manufacturing techniques, feasible to make stamped light metal wheel	Alcoa					4 WH	AI 5/15/77 p. 32

FIGURE B-14. WHEELS WORKSHEETS (Concluded)

APPENDIX C. COMPONENT INVENTORY BY MODEL

TABLE C-1. FOOTNOTES TO COMPONENT INVENTORY BY MODEL

①	Optional
②	Standard equipment
③	Running change
④	Selected models such as: California or cars loaded with options or certain engines
⑤	Front
⑥	Rear
⑦	Special models (anniversary models)
⑧	Except XR-7
⑨	Standard on cars w/radials
⑩	Standard on cars w/302CID V-8
⑪	Station Wagon
⑫	Standard on cars w/5 liter engines (351 CID V-8)
Ⓐ	replaces steel
Ⓑ	replaces iron
Ⓒ	replaces Al

Front end ≡ Fascia (or Facia) ≡ bumper, fender extension, hood extension, grille frame and headlamp bezels.

GM	CTP-MCI 4/30/78																								
Mkt. Class	Model	Body Type	Front wheel arive	Chrome plated HSS face bars	Al reinforcement bars	Phase II catalyst	Tamperproof carburetor	One piece FRP steering column	New sheet metal	Al hood	Automatic level control (rear shocks)	Diesel engine (350 CID gas)	MISAR	GM 980X HS steel steering system reinforcement	Plastic fender liners	HSLA steel wheels	Nodular iron hypoid gears (cast)	New body	Light weight frame	Bumpers	Smaller engine sizes			
LS	Cadillac	C	83②			80④ 81②	79②	78	80 77	77④		79 or 80①			78Ⓐ	80Ⓑ	78⑥	77	77	77	77			
	Electra	C				80④ 81②	79②	78	80															
	Olds 98	C				80④ 81②	79②	78	80		78①	78①												

FIGURE C-1. GM LUXURY-STANDARD COMPONENT INVENTORY BY MODEL

GM Mkt. Class	CTP-MCI 4/30/78 Model	Body Type	Front wheel drive	Chrome plated HSS face bars	Al reinforcement bars	Phase II catalyst	Tamperproof carburetor	One piece RFP steering column	New sheet metal	Al hood	Automatic level control (rear shocks)	Diesel engine (350 CID gas)	MISAR	GM 980X HS steel steering system reinforcement	Plastic fender liners	HSLA steel wheels	Nodular iron hypoid gears (cast)					
LS	El Dorado	E	67	78 Ⓐ	79	80 ④ 81 ②	79 ②	78								79 Ⓑ						
	Toronado	E	66			80 ④ 81 ②	79 ②	78			78 ①	79 ①	78 ②			79 Ⓑ						
	Riviera	E, B	79 ②			80 ④ 81 ②	79 ②	78								79 Ⓑ	78 ⑥					

FIGURE C-1. GM LUXURY-STANDARD COMPONENT INVENTORY BY MODEL (Concluded)

GM C/E Body Luxury Standard CTP-MCI 4/30/78 COMPONENT REFERENCE	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia = RIM	Soft facia: glass reinforced	Front wheel drive	Phase II catalyst	Tamperproof carburetor	FRP steering column	New sheet metal	Al hood	Automatic level control	Diesel engine 350 CID	MISAR	HS steel steering reinforce.	Plastic fender liners	HSLA steel wheels	Nodular iron hypoid gears (cast)	New Body	Light weight frame	Bumpers	Smaller engine sizes
WAR 2/27/78 p. 68										x																
AMM/MN 1/30/78 p. 8			x			x													x							
AMM/MN 1/16/78 p. 28											x															
AMM/MN 1/23/78 p. 17											x															
AN 2/13/78 p. 46										x																
WAR 1/16/78 p. 18												x														
MT 2/78 p. 64													x													
AN 2/6/78 p. 1														x												
AI 10/1/77 p. 24															x	x										
AI 10/1/77 p. 45																	x	x								
WAR 1/16/78 p. 17											x															
AMM/MN 2/6/78 p. 15			x																x							
WAR 3/6/78 p. 74															x											
WAW 4/78 p. 64																				x						
AN 3/27/78 p. 6																					x					
AMM/MN 3/20/78 p. 1																					x					
AN 4/10/78 p. 1																	x									
WAW 4/78 p. 72										x																
AMM/MN 11/21/77 p. 13													x													
WAR 10/17/77 p. 331																						x				
AMM/MN 4/25/77 p. 14															x											
AI 9/15/76 p. 25-26														x									x	x	x	x
WAR 9/6/76 p. 282														x									x	x	x	x

FIGURE C-2. GM LUXURY-STANDARD COMPONENT CROSS-REFERENCE MATRIX

GM

CTP-MCI 4/30/78
Page 1

Mkt. Class	Model	Body Type	Diesel 350 V-8 (Olds)	Front wheel drive	Chrome sputtered plastic grilles	Conventional rear drive	200 4 transmission	350 3 speed automatic transmission	New sheet metal	Tamperproof carburetor	FRP steering column	Turbocharged V-6	Al reinforcement bar	Phase II catalyst	Al intake manifold	Fiberglass belted radials	Tripmaster	Automatic level control (rear shocks)	Electronic spark selection	Nodular iron hypoid gears (cast)	Al hoods -	HSLA steel frame	Reduced tire tread
S	LeSabre	8				80	80	80	80 77	79②	78	78①	78	80④ 81②		78②④				78⑥		77	77
	Delta 88	8	78①			80	80	80	80	79②	78		78	80④ 81②		78②④		78①		78⑥	77	77	77
	Pontiac	8				80	80	80	80	79②	78		78	80④ 81②		78②④				77½⑥③		77	77
	Chevrolet Caprice, Impala	8			77	80	80	80	80	79②	78		78	80④ 81②	78 77①④	78②④				78⑥		77	77
I	Seville	K	78½①	80						79②	78		78	80④ 81②	78		78①		78				

FIGURE C-3. GM STANDARD (PLUS SEVILLE) COMPONENT INVENTORY BY MODEL

GM Mkt. Class	CTP-MCI 4/30/78 Page 2 Model	Body Type	Single level intake manifold	Engine: reduced mass	Lighter suspension and brakes	Smaller body	Air pump eliminated	Bumper: HSLA steel w/aluminum	Turbohydramatic transmission													
S	LeSabre	B		77		77																
	Delta 88	B		77		77																
	Pontiac	B	77 ②	77		77			77													
	Chevrolet Caprice, Impala	B		77	77	77	77	77														

FIGURE C-3. GM STANDARD (PLUS SEVILLE) COMPONENT INVENTORY BY MODEL (Concluded)

GM B/K Body
CTP-MCI 4/30/78
STANDARD/
INTERMEDIATE

Page 1

REFERENCE / COMPONENT	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	Diesel engine (350 V-8)	Chrome sputtered plastic grille	Phase II catalyst	Conventional rear drive	Transmission: 200 4	Transmission: 3 sp. 350 autc.	Front wheel drive	New sheet metal	Tamperproof carburetor	FRP steering column	Turbocharge V-6	Al intake manifold	Fiberglass belted radials	Tripmaster	Automatic level control	Electronic spark selection	Nodular Iron hypoid gears(cast	Al hoods	HSLA steel frame	Reduced tire tread
WAR 2/27/78 p. 68										x																			
WAW 2/78 p. 77											x																		
AMM/MN 1/16/78 p. 28												x																	
AMM/MN 1/23/78 p. 17												x																	
AMM/MN 2/27/78 p. 42										x																			
AMM/MN 2/13/78 p. 16													x	x	x														
AN 2/13/78 p. 46																x	x												
WAR 1/16/78 p. 18																		x											
MT 2/78 p. 64																			x										
AN 2/6/78 p. 1																	x												
R&T 2/78 p. 89																				x									
WAW 2/78 p. 90										x																			
AMM/MN 10/24/77 p. 22											x																		
WAW 10/77 Adv.						x																							
AMM/MN 12/12/77 p. 14																				x									
AMM/MN 12/12/77 p. 13																					x								
AI 12/1/77 p. 47																					x								
AI 12/1/77 p. 99																						x							
AI 10/1/77 p. 23																							x	x					
AI 10/1/77 p. 45										x															x				
AN 4/10/78 p. 1										x																			
WAW 4/78 p. 72																x													

FIGURE C-4. GM STANDARD (PLUS SEVILLE) COMPONENT CROSS-REFERENCE MATRIX

GM B/K Body CTP-MCI 4/30/78 STANDARD/ INTERMEDIATE COMPONENT Page 2 REFERENCE	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	Diesel engine (350 V-8)	Chrome sputtered plastic grille	Phase II catalyst	Conventional rear drive	Transmission: 200 4	Transmission: 3 sp. 350 auto.	Front wheel drive	New sheet metal	Tamperproof carburetor	FRP steering column	Turbocharge V-6	Al intake manifold	Fiberglass belted radials	Tripmaster	Automatic level control	Electronic spark selection	Nodular Iron hypoid gears(cas	Al hoods	HSLA steel frame	Reduced tire tread	Single level intake manifold (steel)	Engine: reduced mass	Lighter suspension & brakes	Smaller body	Air pump eliminated	Bumper: HSLA steel w/Al	Turbohydramatic transmission
AMM/MN 11/21/77 p. 13																			x																	
WAR 10/15/77 p. 331																										x										
AMM/MN 4/25/77 p. 14																											x									
AI 11/1/77 p. 37																												x								
AI 5/15/77 p. 27																													x							
WEU 10/29/76 p. 1, 3																					x															
AI 9/15/76 p. 36																														x	x					
MT 10/76 p. 42																																				x
AI 9/15/76 p. 24																																				x
M.Design 9/9/76 p. 19																												x							x	
AI 9/15/76 p. 21																												x							x	
AI 9/15/76 p. 35																																		x		
WAW 9/76 p. 35																																x	x		x	
AI 9/15/76 p. 22																	x											x					x		x	

FIGURE C-4. GM STANDARD (PLUS SEVILLE) COMPONENT CROSS-REFERENCE MATRIX (Concluded)

GM

CTP-MCI 4/30/78
Page 1

Mkt Class	Model	Body Type	SMC front end reinforcement	Al hoods	Al master brake cylinder	Phase II catalyst	Tamperproof carb	FRP steering column	200 cu. in. V-6 with dualjet carb	Turbocharge V-6	2.5ℓ 4 cyl. engine	Al brake drums	Chrome plated steel bumpers w/steel reinforce.	Chrome plated steel w/Al reinforcement	RIM fascias	Steel fender liners	Plastic fender liners	Al intake manifold	Plastic Fender skirts	Al deck lids	Al wheels -	Compact spare tire	Reduced wheel size
I	Century	A			78⑧	80④ 81②	79②	78				70 78④⑥	78				78	78				78	78
	Cutlass	A		78④Ⓐ	78⑧	80④ 81②	79②	78				78④⑥	78	78④			78	78				78	78
	LeMans	A			78⑧	80④ 81②	79②	78			79	78④⑥			78	78		78			78①	78	78
	Chevelle/Malibu	A			78⑧	80④ 81②	79②	78	78②				78				78	78①	78		78	78	78

FIGURE C-5. GM INTERMEDIATE COMPONENT INVENTORY BY MODEL

GM

CTP-MCI 4/30/78
Page 2

Mkt. Class	Model	Body Type	Fixed window in rear No window regulator	Steel belted radials	Fiberglass belted radials	Sliding sun roofs	Automatic level control (shocks)	Radial 4-cylinder A/C compressor	Al radiator support	Thinner glass	SMC front end header panels	Dualjet carburetor	Diesel 260 CID V-8	Redesigned disc brake	Stamped HSLA steel door beams	HSLA steel frame							
I	Century	A	78	78②						78		79		78	78	78							
	Cutlass	A	78	78②		78①	78①			78		79	79①	78	78	78							
	LeMans	A	78	78②				78	78	78		79		78	78	78							
	Chevelle/Malibu	A	78		78②					78	78	79		78	78	78							

FIGURE C-5. GM INTERMEDIATE COMPONENT INVENTORY BY MODEL (Continued)

GM

CTP-MCI 4/30/78

Page 1

Mkt. Class	Model	Body Type	SMC front end reinforcement	Al hoods	Al master brake cylinder	Phase II catalyst	Tamperproof carb	FRP steering column	200 cu. in. V-6 with dualjet carb	Turbocharge V-6	2.5 ℓ 4 cyl. engine	Al brake drums	Chrome plated steel bumpers w/steel reinforce.	Chrome plated steel w/Al reinforcement	RIM fascias	Steel fender liners	Plastic fender liners	Al intake manifold	Plastic fender skirts	Al deck lids	Al wheels	Compact spare tire	Reduced wheel size
I	Monte Carlo	Asp	78		78Ⓑ	80④ 81②	79②	78							78		78	78①	78	78		78	78
	Grand Prix	Asp		78④ Ⓐ	78Ⓑ	80④ 81②	79②	78				78④ ⑥		78	78	78					78①	78	78
	Regal	Asp		78④ Ⓐ	78Ⓑ	81② 80④	79②	78		78①		78④ ⑥		78			78	78		78		78	78

FIGURE C-5. GM INTERMEDIATE COMPONENT INVENTORY BY MODEL (Continued)

GM

CTP-MCI 4/30/7B

Page 2

Mkt. Class	Model	Body Type	Fixed window in rear No window regulator	Steel belted radials	Fiberglass belted radials	Sliding sun roof	Automatic level control (shocks)	Radial 4 cyldiner A/C compressor	Al radiator support	Thinner glass	SMC front end header panels	Dualjet carburetor	Diesel 260 CID V-8	Redesigned disc brake	Stamped HSLA steel door beams	HSLA steel frame							
I	Monte Carlo	Asp	78	78②						78	78	79		78		78							
	Grand Prix	Asp	78	78②				78	78	78				78		78							
	Regal	Asp	78	78②						78		79		78		78							

FIGURE C-5. GM INTERMEDIATE COMPONENT INVENTORY BY MODEL (Concluded)

INTERMEDIATES GM A/ASP BODY CTP-MCI 4/30/78 Page 1 REFERENCE / COMPONENT	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia : RIM	Soft facia: glass reinforced	SMC front end reinforcement	Steel fender liners	Plastic fender liners	Al hoods	Al master brake cylinder	Phase II catalyst	Tamperproof carburetor	FRP steering column	200 CID V-6 dualjet carb	Turbocharged V-6	2.5 4 cylinder	Al brake drum	Al intake manifold	Al deck lids	Al wheels	Compact spare tire	Reduced wheel size	Fixed window no regulator	Plastic fender skirts	Steel belted radials	Fiberglass belted radials	Sunroofs	Automatic level control	A/C compressor	Al radiator support	Thinner glass	SMC front end panels
MT 2/78 p. 64										x							x																			
AMM/MN 1/30/78 p. 1													x																							
AN 2/27/78 p. 8										x				x																						
AMM/MN 2/6/78 p. 13													x																							
AMM/MN 1/16/78 p. 28															x																					
AMM/MN 1/23/78 p. 17															x																					
WAR 1/16/78 p. 18																x																				
WAW 2/78 p. 67																													x							
R&T 2/78 p. 89																			x																	
AN 1/30/78 p. 1																				x																
AI 10/1/77 Adv.														x																						
WAR 8/29/77 p. 275																					x															
WAR 9/16/77 p. 305	x	x	x	x	x	x	x	x	x		x	x	x																							
WAR 10/77 Adv.						x																														
AMM/MN 12/12/77 p. 14																			x																	
AMM/MN 12/12/77 p. 13																						x														
AMM/MN 12/5/77 p. 47			x			x							x																							
WAR 12/5/77 p. 389																							x	x												
AI 12/1/77 p. 99																					x				x	x										
AI 10/1/77 p. 22			x			x	x	x		x			x						x		x			x	x	x	x	x	x	x	x	x	x	x		
AI 10/1/77 p. 45																		x																		
WAW 3/78 p. 59																																			x	

FIGURE C-6. GM INTERMEDIATE COMPONENT CROSS-REFERENCE MATRIX

INTERMEDIATES
GM A/ASP BODY
CTP-MCI 4/30/78
Page 2

REFERENCE COMPONENT	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	SMC front end reinforcement	Steel fender liners	Plastic fender liners	Al hoods	Al master brake cylinder	Phase II catalyst	Tamperproof carburetor	FRP steering column	200 CID V-6 dualjet carb	Turbocharged V-6	2.5 4 cylinder	Al brake drum	Al intake manifold	Al deck lids	Al wheels	Compact spare tire	Reduced wheel size	Fixed window no regulator	Plastic fender skirts	Steel belted radials	Fiberglass belted radials	Sunroofs	Automatic level control	A/C compressor	Al radiator support	Thinner glass	SMC front end panels	Dualjet carburetor	260 CID V-8 diesel	Redesigned disc brake	HSLA steel door beams	HSLA steel frame
WAW 3/78 p. 115																																				x					
AMM/MN 7/25/77 p. 14																																				x					
AI 10/1/77 p. 24																																				x					
AN 2/2/78 p. 20																																				x					
AMM/MN 2/20/78 p. 14																																				x					
WAR 3/6/78 p. 74													x																												
AE 3/78 p. 22														x																											
MT 3/78 p. 9								x																																	
MT 3/78 p. 12																																					x				
AN 4/10/78 p. 1																																						x			
AI 11/15/77 Adv.																																							x		
AMM/MN 6/27/77 p. 11			x	x		x																																			
AMM/MN 11/21/77 p. 13																	x																								
MT 12/77 p. 20																									x																
WAR 8/29/77 p. 276																									x																
AMM/MN 6/20/77 p. 15			x			x	x						x																												
AMM/MN 8/22/77 p. 12																																								x	
AMM/MN 8/1/77 p. 5												x																													
AMM/MN 4/25/77 p. 14													x																												
AI 11/1/77 p. 37																																									x

FIGURE C-6. GM INTERMEDIATE COMPONENT CROSS-REFERENCE MATRIX (Concluded)

GM CTP-MCI 4/30/78

Mkt. Class	Model	Body Type	Front wheel drive	Phase II catalyst	Cast Iron 165 CID V-6	Tamperproof carb	RIM bumper	Al intake manifold	Al cowl vent panels	Glass-fiber reinforced plastic header panel	Dualjet carburetor	HSLA steel wheels											
C	Buick Skylark	X	80	80 ④ 81 ②		79 ②		78	80 Ⓐ	78 ③	79	80 Ⓑ											
	Omega	X	80	80 ④ 81 ②		79 ②		78	80 Ⓐ		79	80 Ⓑ											
	Ventura (Phoenix)	X	80	80 ④ 81 ②		79 ②		78	80 Ⓐ		79	80 Ⓑ											
	Chevy Nova	X	80	80 ④ 81 ②		79 ②		78	80 Ⓐ		79	80 Ⓑ											
	Wagon/Mini Van	X	79½ ②	80 ④ 81 ②	80																		

FIGURE C-7. GM COMPACT COMPONENT INVENTORY BY MODEL

GM Mkt Class	CTP-MCI 4/30/78 Model	Body Type	Front wheel drive	Phase II catalyst	Cast Iron 165 CID V-6	Tamperproof carb	RIM bumper	Al intake manifold	Al cowl vent panels	Glass-fiber reinforced plastic header panels	Dualjet carburetor
C	Chevy Camaro	F		80④ 81②		79②	78Ⓒ	78			79
	Pontiac Firebird	F		80④ 81②		79②	78	78			79

FIGURE C-7. GM COMPACT COMPONENT INVENTORY BY MODEL (Concluded)

GM X, F BODY COMPACTS

CTP MCI 4/30/78

REFERENCE \ COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced			Front Wheel Drive	Phase II Catalyst	Cast Iron 165 CID V-6	Tamperproof Carburetor	Al Intake Manifolds	Al Cowl Vent Plates	Glass FRP Header Panel	Dualjet carburetor	HSLA steel wheels
WAR 2/27/78 p. 68												X								
AMM/MN 1/16/78 p. 28													X							
AMM/MN 1/23/78 p. 17													X							
AMM/MN 2/27/78 p. 14														X						
WAR 1/16/78 p. 18															X					
WAR 9/26/77 p. 305								X												
AMM/MN 12/12/77 p. 13																X				
AMM/MN 3/13/78 p. 20												X					X			
AMM/MN 2/20/78 p. 14																		X		
MT 3/78 p. 9								X												
MT 3/78 p. 12																			X	
AMM/MN 3/20/78 p. 1																				X

FIGURE C-8. GM COMPACT COMPONENT CROSS-REFERENCE MATRIX

GM

CTP MCI 4/30/78

Mkt. Class	Model	Body Type	Phase II Catalyst	Tamperproof Carb	Al Intake Manifolds	Al Wheels	RIM Fascias
SC	Starfire	Hsp	81 ② 78 ④	79 ②	78		78
	Skyhawk	Hsp	80 ④ 81 ②	79 ②			78
	Vega (discontinued in 1977)						
SC	Monza	Hsp U	81 ② 78 ④	79 ②	78	78 ①	78
	Sunbird (includes Astre in 1978)	Hsp U	81 ② 78 ④	79 ②	78	78 ①	

FIGURE C-9. GM SUBCOMPACT COMPONENT INVENTORY BY MODEL

GM H/H sp BODY
SUBCOMPACT
CTP MCI 4/30/78

REFERENCE / COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced		Phase II Catalyst System	Tamperproof Carb.	Al Intake Manifolds	Al Wheels
AMM/MN 1/16/78 p. 28											X			
AMM/MN 1/23/78 P. 17											X			
WAR 1/16/78 p. 18												X		
AMM/MN 12/12/77 p. 13													X	
WAR 12/5/77 p. 389														X
MT 3/78 p. 9								X						

FIGURE C-10. GM SUBCOMPACT COMPONENT CROSS-REFERENCE MATRIX

GM Mkt. Class	CTP-MCI 4/30/78 Model	Body Type	All Plastic Front Seats	Chrome Sputtered Plastic Grilles	Phase II Catalyst	Tamperproof Carb	Automatic Seat Belt	Al Intake Manifolds	Fuel Tank: Polyethylene Liner in a Steel Tank	Al Wheels	Plastic Hood	Plastic Removable Roof Panels (Glass FRP)	Dual Jet carburetor	Plastic Body panels via inmold coating	Al transmission case								
SC	Corvette	Y	79 ② 78 ⑦		80 ④ 81 ②	79 ②			78	78 ①	80-82	78½ ③		80	77								
Mini	Chevette	T	79-80	79	80 ④ 81 ②	79 ②	① 78½ ③	② 78 ⑧					79 ④										
	Corp. Average																						

FIGURE C-11. GM MINI (PLUS CORVETTE) COMPONENT INVENTORY BY MODEL

GM Y/T Body SUBCOMPACT/MINI

CTP MCI 4/30/78

REFERENCE \ COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced	All Plastic Seat	Plastic Grilles/Chrome coated	Phase II Catalyst	Tamperproof Carb.	Automatic Seat Belt	Al Intake Manifold	Fuel Tank (plastic)	Al Wheels	Plastic Hood	Glass FRP Removable Roof Panels	Plastic body panel/inmold coat	Al transmission case	Dual Jet carburetor
WAW 6/77 p. 26										X												
WAR 2/27/78 p. 67										X												
WAW 2/78 p. 77											X											
AMM/MN 1/16/78 p. 28												X										
AMM/MN 1/23/78 p. 17												X										
WAR 1/16/78 p. 18													X									
WAW 1/78 p. 45										X												
AN 2/20/78 p. 3														X								
AMM/MN 10/24/77 p. 22											X											
AMM/MN 12/19/77 p. 29															X							
AI 12/1/77 p. 51																X						
WAR p. 389 12/5/77																	X					
AI 3/78 p. 11										X												
MT 3/78 p. 10										X	X											
AN 2/27/78 p. 20																		X		X		
AMM/MN 2/20/78 p. 14										X									X			
WEU 3/17/78 p. 8															X							
AMM/MN 8/15/77 p. 5																				X		
AI 7/1/77 p. 33																					X	
MT 3/78 p. 12															X							X
WAR 3/13/78 p. 83														X								
AI 3/78 p. 14														X								
WAW 4/78 p. 64										X												

FIGURE C-12. GM MINI (PLUS CORVETTE) COMPONENT CROSS-REFERENCE MATRIX

FORD

CTP-MCI 4/30/78
Page 1

Mkt Class	Model	T-roof	Washer fluid indicator	Redesigned body	Al intake manifolds	Mild steel facebar Al reinforcement	Al wheels	Front bumper air spoilers (A/D)	Rear floorpan air deflector (A/D)	Bumper to fender shields (A/D)	Light wt. power steering pump	Underbody rear air deflector	High strength steel frames	V-8 engines	High strength steel face bars w/Al bumper reinforce.	Al water pumps	Al engine rear covers	Cast Mg housings w/tilt-type steering columns	Chrome plated Al bumpers	Thinner glass	High strength steel suspension	High strength steel reinforcements	High strength mounting brackets
LS	Lincoln		78②			78					78												
	Mark IV					73																	
	Mark V		78②			78	78				78												
	Thunderbird					73																	

FIGURE C-13. FORD LUXURY-STANDARD COMPONENT INVENTORY BY MODEL

FORD

CTP-MCI 4/30/78

Page 1

Mkt Class	Model	T-roof	Washer fluid indicator	Redesigned body	Al intake manifolds	Mild steel facebar Al reinforcement	Al wheels	Front bumper air spoilers (A/D)	Rear floorpan air deflector (A/D)	Bumper to fender shields (A/D)	Light wt. power steering pump	Underbody rear air deflector	High strength steel frames	V-8 engines	High strength steel face bars w/Al bumper reinforce.	Al water pumps	Al engine rear covers	Cast Mg housings w/tilt-type steering columns	Chrome plated Al bumpers	Thinner glass	High strength steel suspension	High strength steel reinforcements	High strength mounting brackets
S	LTD			79	79 Ⓑ ④			78	78	78			79	79 ②	79	79 ④	79	79 ①	79 ⑪ ⑤	79	79	79	79
	Marquis			79	79 Ⓑ ④			78 ④			78	78	79	79 ②	79	79 ④	79	79 ①	79 ⑪ ⑥	79	79	79	79

FIGURE C-14. FORD STANDARD COMPONENT INVENTORY BY MODEL

Ford CTP-MCI 4/30/78
Page 2

Mkt. Class	Model	EEC II	Redesigned rear axle																				
S	LTD	79 ④	79																				
	Marquis	79 1½	79																				

FIGURE C-14. FORD STANDARD COMPONENT INVENTORY BY MODEL (Concluded)

Ford LS/S MKT. CLASS CTP MCI 4/30/78 COMPONENT REFERENCE	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced			T-Roof	Washer Fluid Indicator	Redesigned Body	Al Intake Manifolds	Al Wheels	Front Bumper Air Spoilers	Rear Floor Pan Air Deflectors	Bumper to Fender Shields	Light Wt. Power Steering Pump	Underbody Rear Deflectors	High Strength Steel Frames	V-B Engines	Al Water Pumps	Al Engine Rear Covers	Cast Mg Housing w/Tilt Steer.	Thinner Glass	HS steel suspension	HS steel reinforced	HS steel Mtg. Bracket	EEC II	Redesigned rear axle								
WAR 1/23/78 p. 27												X																												
AN 2/20/78 p. 124													X																											
AN 2/20/78 p. 1														X																										
AMM/MN 11/14/77 p. 21															X																									
WAR 9/26/77 p. 305	X			X		X																																		
AMM/MN 12/19/77 p. 29															X																									
WAR 12/5/77 p. 389																X																								
AI 12/1/77 p. 35						X																																		
AI 10/1/77 p. 33																	X	X	X	X	X																			
AMM/MN 3/27/78 p. 5			X		X	X	X								X							X	X	X	X	X	X	X	X	X										
AMM/MN 4/17/78 p. 4																															X									
AMM/MN 4/10/78 p. 41				X	X	X	X								X							X		X																
WEU 4/28/78 p. 6																															X									
WAR 4/17/78 p. 123																															X									
AMM/MN 7/4/77 p. 1					X	X	X																																	
WEU 12/23/77 p. 1																															X									
AE 10/77 p. 37																				X																				
AMM/MN 4/25/77 p. 13																								X																
AMM/MN 3/27/78 p. 5																						X																		
WAR 9/26/77 p. 308																																X								

FIGURE C-15. FORD LUXURY-STANDARD AND STANDARD COMPONENT CROSS-REFERENCE MATRIX

FORD

CTP MCI 4/30/78

Mkt. Class	Model		Washer Fluid Indicator	High Strength Plastic Radiator Supports	Al Wheels	Front Bumper Air Spoilers	Lightwt. Power Steering Pump	Deck Lid Spoilers	Bumper to Fender Shields	EEC 1	Al Hood	Front wheel spindle	Plastic window brackets	T-roof									
I	Versailles		78 ①	80	78 ②		78			78 ⑩	77½ ③ Ⓐ												
	Torino-LTD II			80		78							77 ③ Ⓐ										
	Elite-T'Bird			80								80		78½									
	Montego			80																			
	Cougar			80		78		78 ⑧	78			80	77 ③ Ⓐ										

FIGURE C-16. FORD INTERMEDIATE COMPONENT INVENTORY BY MODEL

FORO INTERMEOIATE CTP MCI 4/30/78 COMPONENT REFERENCE	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced			HS plastic radiator, support	Washer Fluid Indicator	Al Wheels	Front Bumper Air Spoiler	Lightwt. Power Steering Pump	Deck Lid Spoilers	Bumper to Fender Shields	EEC 1	Al Hood	Front wheel spindle	Plastic window brackets	T-roof
WAW 6/77 p. 26												X											
AN 2/20/78 p. 124													X										
WAR 12/5/77 p. 389														X									
AI 10/1/77 p. 33															X	X	X	X					
AI 10/1/77 p. 51																			X				
AMM/MN 3/6/78 p. 31																				X			
WAR 3/6/78 p. 74																				X			
AMM/MN 3/6/78 p. 21																					X		
AMM/MN 4/3/78 p. 13																					X		
Al 12/1/77 p. 37																				X			
AMM/MN 1/31/77 p. 7																						X	
Amm/MN 4/11/77 p. 24																				X			
WAR 1/23/78 p. 27																							X
WAR 12/5/77 p. 389														X									

FIGURE C-17. FORD INTERMEDIATE COMPONENT CROSS REFERENCE MATRIX

FORD

CTP MCI 4/30/78 Page 1

Mkt. Class	Model		Dual Displacement V-8	Al Brake Master Cylinder	Al Bumpers	Al Reinforcements	Al Intake Manifolds	Al Wheels	HSLA Steel Bumper Reinforcement	Al Steering Gear Housing	HSLA Steel Door Beams	Plastic Instrument Panel	Plastic Headlight Housing	Plastic Hood Cowl	Plastic Grille	Thinner Glass	Front Bumper Air Spoilers (A/D)	Steel Belted Radials	Partially Closed Grille (A/D)	Bumper to Fender Shields (A/D)	Rack and Pinion Steering w/variable ratio	Deck Lid Spoilers	Plastic windshield wipers	Compact spare tire
C	Granada		80			78	78④	78									78		78	78				
	Monarch		80			78	78④	78									78		78	78		78		
C	Maverick-Fairmont			79Ⓑ	78Ⓐ				78	78	78	78	78	78	78	78		78(2)			78(1)		78	78
	Comet-Zephyr			79Ⓑ	78Ⓐ				78	78	78	78	78	78	78	78		78(2)			78(1)		78	78

FIGURE C-18. FORD COMPACT COMPONENT INVENTORY BY MODEL

FORD Cont,	CTP-MCI 4/30/78	Steel frame	Redesigned rear axle																				
Mkt. Class	Model																						
C	Granada																						
	Monarch																						
C	Maverick-Fairmont	78	78																				
	Comet-Zephyr	78	78																				

FIGURE C-18. FORD COMPACT COMPONENT INVENTORY BY MODEL (Concluded)

FORD COMPACT

CTP MCI 4/30/78

COMPONENT REFERENCE	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced		Dual Displacement V-8	Al Master Brake Cylinder	Al Intake Manifolds	Al Wheels	Al Steering Gear Housing	HSLA Steel Door Beams	Plastic Instrument Panel	Plastic Headlight Housing	Plastic Hood Cowl	Plastic Grille	Thinner Gage Glass	Front Bumper Air Spoilers	Steel Belted Radials	Partially Closed Grilles	Shields-Bumper to Fender	Rack and Pinion Steering	Deck Lid Spoilers	Plastic windshield wipers	Compact spare tire	Steel frame	Redesigned rear axle
AN 1/16/78 p. 38											X																				
AMM/MN 11/14/77 p. 21												X																			
AE 11/77 p. 87					X																										
WAR 9/26/77 p. 305					X																										
WAW 10/77 Adv					X	X																									
AI 12/1/77 p. 47													X																		
WAR 12/5/77 p. 389														X																	
AI 12/1/77 p. 35				X												X															
AI 12/1/77 p. 99															X																
AI 10/1/77 p. 33					X											X	X	X	X	X	X	X	X	X	X	X	X				
WAW 4/78 p. 55																												X			
Boston Globe 3/26/78 p. H1															X																
AMM/MN 8/22/77 p. 12																X															
AI 5/15/77 p. 14																													X		
WAR 5/29/77 p. 276																													X		
AMM/MN 5/27/77 p. 11																														X	
WAR 9/26/77 p. 308																															X

FIGURE C-19. FORD COMPACT COMPONENT CROSS-REFERENCE MATRIX

Ford Mkt. Class	CTP-MCI 4/30/78 Model	Plastic Fuel tank	Elliptical tires	T-roof	Front wheel drive	Al 4-cylinder engine <2.3L	2.3L engine	Turbocharge 2.3L 4-cylinder	Al face bar bumper	Al wheels	Al reinforcement bar	Rack and pinion steering w/ variable ratio	Electronically controlled carburetor	3-way catalyst	Al intake manifolds	Al transmission case	Al water pump	RIM facia	HSLA reinforcement	Urethane face bar	Turbocharge 4-cylinder' 1.6L			
SC	Pinto/Erika (1981)				81	81 Ⓑ ② ④	80 ①		78	78	73	78 ①	78 ④	78 ④	74						81			
	Bobcat/Erika (1981)				81	81 Ⓑ ② ④	80 ①		78			78 ①	78 ④	78 ④	74	81	81							
SC	Mustang	78 Ⓐ ④	79 ①	77½ ①				79		78		78 ①			74			79 ⑤ ⑥	78	78				
	Capri (produced in U.S. in 1979)		79 ①					79										79 ⑤ ⑥						

FIGURE C-20. FORD SUBCOMPACT COMPONENT INVENTORY BY MODEL

FORD SUBCOMPACT
CTP-MCI 4/30/78
Page 1

REFERENCE / COMPONENT	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	Soft face bar	Plastic fuel tank	Elliptical tire	T-roof	Front wheel drive	Al 4-cyl. engine <2ℓ	2.3ℓ engine	Turbocharge 4-cyl. 2.3L	Al wheels	Rack and pinion steering	3-way catalyst	Al intake manifolds	Al transmission case	Al water pump	Plastic windshield wiper blds	Special wheel/tire	Turbocharged 4-cyl. 1.6L
WAW 6/77 p. 26								X																		
WAR 1/2/78 p. 5											X															
WAR 1/23/78 p. 27													X													
BW 2/27/78 p. 104												X														
PS 2/78 p. 46														X	X	X										
AN 1/16/78 p. 1																	X									
WAW 1/78 p. 37														X												
AMM/MN 11/21/77 p. 12								X		X																
WAR 9/26/77 p. 305				X	X					X																
WAW 10/77 Adv.					X																					
AMM/MN 4/18/77 p. 16								X																		
WAR 12/5/77 p. 289																		X								
AI 12/1/77 p. 35						X																				
AI 10/1/77 p. 33																			X							
AI 10/1/77 p. 51																				X						
WEU 3/17/78 p. 8																					X					
AMM/MN 1/9/78 p. 19														X	X						X	X	X			
MT 3/78 p. 9										X																
PS 3/78 p. 46														X	X											
WAW 4/78 p. 9								X																		
WAW 4/78 p. 55																								X		
PS 3/78 p. 46																									X	

FIGURE C-21. FORD SUBCOMPACT COMPONENT CROSS-REFERENCE MATRIX

FORD SUBCOMPACT Page 2 CTP-MCI 4/30/78 COMPONENT REFERENCE	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	Soft face bar	Plastic fuel tank	Elliptical tire	T-roof	Front wheel drive	Al 4-cyl. engine < 2 ℓ	2.3 ℓ engine	Turbocharge 4-cyl. 2.3 ℓ	Al wheels	Rack and pinion steering	3-way catalyst	Al intake manifolds	Al transmission case	Al water pump	Plastic winshields wiper blds.	Special wheel/tire	Turbocharge 4-cyl. 1.6L
AN 4/17/78 p. 55																	X									
AMM/MN 4/24/76 p. 22															X											
WEU 4/28/78 p. 1															X		X									
WAW 1/78 p. 6												X														

FIGURE C-21. FORD SUBCOMPACT COMPONENT CROSS-REFERENCE MATRIX (Concluded)

FORD

CTP MCI 4/30/78

Mkt. Class	Model	Body Type	Power Steering Pump - Al Reservoir-Glass Rein. Nylon	Thinner Glass
Mini	Fiesta		78	78
	Corp. Average		78	

FIGURE C-22. FORD MINI COMPONENT INVENTORY BY MODEL

FORD MINI CTP MCI 4/30/78 COMPONENT REFERENCE	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced		Al Power Steering Pump	Thinner Glass
AI 12/1/77 p. 99											X	
AI 10/1/77 p. 33												X

FIGURE C-23. FORD MINI COMPONENT CROSS-REFERENCE MATRIX

Chrysler

CTP MCI 4/30/78

Mkt. Class	Model	Body Type	Thin wall cast iron 225 CID 6-cyl. engine	Al Wheels	Chrome plated Al bumpers	Plastic front-end panels																	
S	Newport	C/R	80-81																				
	Gran Fury/Royal Monaco (dropped in 1978)	C																					
	St. Regis	R	80-81																				
LS	R-body (New Yorker)	C/R	80-81	79②	79①	79																	

FIGURE C-24. CHRYSLER LUXURY-STANDARD AND STANDARD COMPONENT INVENTORY BY MODEL

CHRYSLER R-BODY , C-BODY
STANDARD
CTP MCI 4/3D/78

REFERENCE \ COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced	Plastic Front-End Panels		225 CID 6-cylinder engine	Al Wheels
AMM/MN 1/23/78 p. 15												X	
AMM/MN 9/12/77 p. 23					X		X						X
WAW 1D/77 p. 87					X		X			X			X
AMM/MN 7/4/77 p. 12					X		X						
WAR 12/5/77 p. 389													X

FIGURE C-25. CHRYSLER LUXURY-STANDARD AND STANDARD COMPONENT CROSS-REFERENCE MATRIX

Chrysler	CTP MCI 4/30/78																							
Mkt. Class	Model	Body Type	Cast Iron 225 CID 6-cylinder (thin walled)	T-roof	HSLA steel bumpers (one-piece)	Al fascia wheel																		
I	Fury (dropped in 79)	B	80-81		77 ③																			
	Monaco Coronet/ Charger (dropped in 79)	B	80-81		77 ③	78 ①																		
I	Cordoba	B sp		78 ①																				
	Charger S.E.	B sp																						

FIGURE C-26. CHRYSLER INTERMEDIATE COMPONENT INVENTORY BY MODEL

Chrysler Mkt. Class	CTP MCI 4/30/78 Model	Body Type	Cast Iron 225 CID 6-cylinder (thin walled)	T-roof																			
I	Diplomat	M	80-81																				
	LeBaron	M	80-81																				
	New Plymouth	M																					

FIGURE C-26. CHRYSLER INTERMEDIATE COMPONENT INVENTORY BY MODEL (Concluded)

CHRYSLER INTERMEDIATE

CTP MCI 4/30/78

REFERENCE \ COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced		Cast Fe 225 CID 6-cyl (thin walled)	T-roof	Al fascia wheel
AMM/MN 1/23/78 p. 15											X		
AI 10/1/77 p. 36												X	
AMM/MN 6/27/77 p. 11			X	X									
AI 12/1/77 p. 103													X
WEU 6/10/77 p. 1											X		

FIGURE C-27. CHRYSLER INTERMEDIATE COMPONENT CROSS-REFERENCE MATRIX

Chrysler Mkt. Class	CTP MCI 4/30/78 Model	Body Type	Cast Iron 225 CID 6-Cyl.	Series IV light-wt. brake	HSLA steel face bar	Al intake manifolds	Al master brake cylinder	Compact spare	Al wheels														
C	Valiant	A		77																			
	Dart	A																					
C	Volare	F/K (1982)	78 ②		78	78 Ⓑ ③	78		79														
	Aspen	F/K (1982)	78 ②		78	78 Ⓑ ③	78	78 ⑨	79														

FIGURE C-28. CHRYSLER COMPACT COMPONENT INVENTORY BY MODEL

CHRYSLER COMPACT CTP MCI 4/30/78 COMPONENT REFERENCE	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: Rim	Soft Facia: Glass Reinforced			Cast Fe 225 CID 6-cyl.	K Body in '82	Series IV Light Wt. Brake	Al Intake Manifolds	Al Master Brake Cylinder	Compact Spare	Al wheels
AMM/MN 1/23/78 p. 15												X						
AN 2/20/78 p. 127													X					
AE 5/77 p. 44														X				
WAR 9/26/77 p. 305			X															
AMM/MN 12/12/77 p.13															X			
AI 12/1/77 p. 48															X			
AI 12/1/77 p. 99																X		
AI 10/1/77 p. 38																	X	
AMM/MN 3/6/78 p. 10															X			
AN 3/20/78 p. 10																		X
AMM/MN 6/27/77 p. 11			X															

FIGURE C-29. CHRYSLER COMPACT COMPONENT CROSS-REFERENCE MATRIX

CHRYSLER

Mkt Class	Model	Body Type	Firestone high pressure radial tire	Front wheel drive	Soft front end	3-door version	Al bumpers	Al master brake cylinder	Rack & pinion steering	Al intake manifold	Lean burn	Steel unit frame	HSS suspension	Y body car	Al cylinder heads	Lockup torque converter	Al transmission housing	Al wheels	High strength steel outer hood/mild steel inner hood panel	HSS windshield wipers	HSS brake pedals	HSS gearshift mounting reinforcements	HSS fuel tank supports
SC	Omni/Horizon (5 door) Solo/Mirada (3 door)	L	78 ②	78 ②	79	79	78 ② ⑤ ⑥	78 ② ⑧	78 ②	78 ②	78 ②	78 ②	78 ②		78 ②	78	78 ⑧		78	78	78	78	78
	(Imperial?) New Car Luxury (1980-81)	Y												80 or 81									

FIGURE C-30. CHRYSLER SUBCOMPACT COMPONENT INVENTORY BY MODEL

Chrysler CTP-MCI 4/30/78

Mkt. Class	Model	Body Type	Galvanized HSLA steel suspension	Venturi-like aspirator (replace air pump)																			
SC	Omni/Horizon	L	78	78																			
	New car luxury 1980-81 (Imperial?)																						

FIGURE C-30. CHRYSLER SUBCOMPACT COMPONENT INVENTORY BY MODEL (Concluded)

CHRYSLER L-BODY

CTP MCI 4/30/78

REFERENCE / COMPONENT	Mild Steel Face Bar	Mild Steel Reinforcement	HSLA Steel Face Bar	HSLA Steel Reinforcement	Al Face Bar	Al Reinforcement	Chrome Plated	Soft Facia: RIM	Soft Facia: Glass Reinforced	Soft Front-End	RIM bumpers	Firestone High Pressure Radial	Front Wheel Drive	3-Door Version	Al Master Brake Cylinder	Rack and Pinion Steering	Al Intake Manifold	Steel Unit Frame	HSS Suspension	Y Body Car	Radial Ply Tires	Al Cylinder Heads	Lockup Torque Converter	Al Transmission Housing	Al Wheels	HSS Outer Hood/Mild Steel Inner	HSS Windshield Wipers	HSS Brake Pedals	HSS Gear Shift Mounting Reinf.	HSS Fuel Tank Supports	Venturi like aspirator
WAW 2/78 p. 67												X																			
WAR 1/23/78 p. 25													X																		
AN 1/16/78 p.1											X			X																	
R&T 1/78 p. 49					X										X	X	X	X													
PS 1/78 p. 37													X																		
MT 1/78 p. 29													X					X													
WAW 1/78 p. 30					X														X												
WAW 1/78 p. 9																				X											
WAW 1/78 p. 37													X	X							X	X									
WAR 12/1/77 p. 397					X									X									X								
WAW 10/77 p. 87					X																										
AMM/MN 12/12/77 p. 13																	X														
AI 12/1/77 p. 47																	X					X		X							
WAR 12/5/77 p. 389																									X						
AI 12/1/77 p. 99															X																
AMM 3/6/78 p. 10																										X	X	X	X		
AMM/MN 2/27/78 p. 15																			X								X		X	X	
WAW 4/78 p, 63															X				X							X	X	X			
WEU 3/3/78 p. 1																															X
WEU 4/14/78 p. 2											X																				

FIGURE C-31. CHRYSLER SUBCOMPACT COMPONENT CROSS-REFERENCE MATRIX

AMC CTP-MCI 4/30/78

Mkt. Class	Model	Body Type	121 CID Audi 4-cylinder	4 speed gear box	Al transmission case	HSLA in sill area	Body shortened 3"	Emission control devices added															
SC	Gremlin/Spirit (1979)				77 Ⓘ	77	77	77															
	Javelin New car 1979		79	79 Ⓘ																			
M	New car (1980-81)																						

FIGURE C-32. AMC INTERMEDIATE AND COMPACT COMPONENT INVENTORY BY MODEL

AMC SC/M
CTP-MC1 4/30/78

REFERENCE / COMPONENT	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	121 CID Audi 4-cylinder	4 speed gear box	Al transmission case	HSLA in sill area	Body shortened 3"	Emission control devices
MT 1/78 p. 14										x					
AN 4/10/78 p. 1											x				
AI 7/1/77 p. 33												x			
AMM/MN 6/27/77 p. 11													x		
AN 11/1/76 p. 21														x	
A1 9/15/76															x
AN 11/1/76 p. 21															x

FIGURE C-33. AMC INTERMEDIATE AND COMPACT COMPONENT CROSS-REFERENCE MATRIX

AMC	CTP-MCI 4/30/78			face bar		ion case	strument panel	steel in sill area	Audi 4-cylinder engine	Emission controls added													
	Pacer			78	78	77①			77	77													

FIGURE C-34. AMC SUBCOMPACT AND MINI COMPONENT INVENTORY BY MODEL

AMC I/C CTP-MCI 4/30/78 COMPONENT / REFERENCE	Mild steel face bar	Mild steel reinforcement	HSLA steel face bar	HSLA steel reinforcement	Al face bar	Al reinforcement	Chrome plated	Soft facia: RIM	Soft facia: glass reinforced	2 ℓ engine	Al wheels	Al transmission case	ABS instrument panel	HSLA steel in sill area	Emission controls added
AN 1/30/78 p. 40										x					
WAW 1/78 p. 53										x					
WAR 9/16/77 p. 305			x												
WAR 12/5/77 p. 389											x				
AI 7/1/77 p. 33												x			
WAR 9/26/77 p. 306			x												
AN 10/10/77 p. 20													x		
AMM/MN 6/27/77 p. 11														x	
AI 9/15/76															x
AN 11/1/76															x

FIGURE C-35. AMC SUBCOMPACT AND MINI COMPONENT CROSS-REFERENCE MATRIX